Research Article

The Impact and Stability Analysis of Commercial Banks’ Risk Preference on SMEs’ Credit Financing Based on DSGE Model

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As an important driving force for China’s economic transformation and upgrading, the problems of financing difficulties and expensive financing for SMEs have become increasingly prominent. The main objective of this paper was to analyze the impact of financial intermediary departments’ risk preference on corporate finance. Under the revised DSGE framework, this paper discusses the impact and stability analysis of commercial banks’ risk preferences on SMEs’ financing. The results show that positive interest rate shocks inhibit commercial banks’ credit to SMEs, and with the increasing weight of commercial banks’ risk preference for default rate, the trend of credit repression will be intensified.

1. Introduction

The essence of finance is to serve the real economy (Report to the 19th National Congress). With the transformation of China’s economy from high-speed development to high-quality development, maintaining financial system stability has become the focus of China’s economic work. After the subprime mortgage crisis, many economists began to incorporate financial stability into the monetary policy framework [1, 2]. Under the monetary policy goal of stabilizing finance, commercial banks increase the demand for the security of loan funds and reduce the supply of credit to high-risk enterprises. Based on the information asymmetry theory, small and medium-sized enterprises (SMEs) are more likely to produce adverse selection and moral hazard problems, resulting in a decline in the banks nonperforming loan rate and fund security. SMEs are a vital force for national economic and social development, and they play an important and irreplaceable role in stabilizing growth, increasing employment, promoting innovation, and improving people’s livelihood. According to data released by the China Association of Small and Medium Enterprises in 2019, SMEs (including individual industrial and commercial households) account for 94.15 % of the total number of enterprises, the value of the final products and services created is equivalent to 60% of the total GDP, and the tax payment account for 50% of the total national tax. Under the backdrop of world economic growth slowing down, the external financing problem of SMEs is becoming increasingly prominent, and SMEs are troubled by financing constraints. According to data from the China Household Finance Survey, in 2011, the scale of commercial bank credit available to SMEs accounted for 12.2% of the total credit scale; by 2017, the proportion dropped to 9.8%. The purpose of this paper was to analyze how financial intermediary departments’ risk preference affect SMEs financing under the revised DSGE framework.

The existence of financing constraints in SMEs has always been the focus of theoretical attention. On the one hand, information asymmetry believes that the difficulty of financing for SMEs is due to the information asymmetry between banks and enterprises. Stiglitz and Weiss [3] pay attention to the credit decision problem of commercial banks for the first time. In the credit market, information
asymmetry between banks and enterprises is likely to induce adverse selection and moral hazards. Compared with large enterprises, SMEs are prone to lose their credit qualification due to the lack of qualified collateral. In addition, in order to ensure the safety of credit, banks need to pay high supervision costs; otherwise, SMEs will lose their credit qualification due to the lack of qualified collateral. The moral hazard of business operators will damage the interests of commercial banks. In order to reduce operating costs and avoid their own operational risks, banks will tend to implement the policy of reluctant loans to SMEs [4, 5]. Therefore, in the context of mortgage loans as the main loan business of commercial banks, the financing difficulty of SMEs is largely due to the lack of qualified collateral. Casey et al. [5] use Euro area firm-level data since the recent financial crisis, as opposed to credit financing, and smaller, self-rationing borrowers are more likely to apply for grant finance. Farinha and Félix [6] examine the importance of credit qualification due to the lack of qualified collateral. The results suggest that credit supply mostly depends on the firms’ ability to generate cash flows and reimburse their debt, and on the amount of collateral.

On the other hand, based on risk-taking theory, SMEs have a weak ability to bear risk shocks. When the external economy fluctuates, the income of SMEs will have a high degree of uncertainty, and there will be a high risk of default on bank credit. The results of Blumberg and Letterie [7] show that the rejection of loans depend largely on corporate commitments and signals of loan repayment, as well as the chance of success of investment projects. Ioannidou et al. [8], Bonfim and Soares [9] studied from the perspective of bank risk-taking and found that when interest rates were low, Banks would lend more to risky companies in pursuit of more returns. This shows that under certain conditions, the change of risk preference of commercial Banks can have an impact on the credit level of SMEs. At the same time, Chinese researchers incorporate the problem of corporate default risk into the credit decision-making mechanism when they focus on commercial banks’ credit decision-making. Pang [10] discusses the credit decision-making model and mechanism of commercial banks under the default risk framework. Dai et al. [11] study the relationship between credit level and bank loans of listed companies based on China’s “laolian” data. The results show that the financing cost of high-risk enterprises is determined by the high default rate of enterprises. Based on existing literature, the main reasons of financing difficulty and high cost for SMEs could be summarized as follows: (1) The lack of loan collateral provided by SMEs is easy to cause financing difficulties; (2) SMEs have a high risk of default after they successfully obtain loans, which forces commercial banks to raise the loan interest rate to make up for the losses caused by default. In that case, the problem of expensive financing is formed.

Although the problem of credit financing for SMEs has always been a hot issue in the theoretical field, it is mostly limited to microscopic empirical studies of available data [12–14]. Using the revised DSGE framework, this paper studies the credit decision-making mechanism of commercial banks on SMEs, and examines the impact of different risk preference weights on SMEs’ credit financing. With the introduction of the financial accelerator mechanism into the DSGE framework by Bernanke et al. [15], many scholars have introduced a separate financial intermediary sector into the model [16–19]. In this paper, the DSGE model including the banking system is used as the basic analysis tool, and we reconstruct the enterprise sector of the model to depict the influence of risk tolerance of commercial banks on SMEs credit financing. In order to analyze this problem accurately, this paper not only describes the loan behavior of commercial banks to SMEs but also considers its role in the macro-economy as well as the influence and feedback of monetary policy transmission.

This paper makes several contributions to related literature. First, previous studies assume that commercial banks are fully competitive, so the debt contract between commercial banks and enterprises depends on the return of enterprises [20, 21]. This paper assumes that commercial banks are monopolistic competition, and the debt contract between SMEs and commercial banks depends on the loan interest rate elasticity of commercial banks, which is introduced into the risk-preference analysis framework of commercial banks for SMEs. Second, considering the state-owned nature, China’s commercial banks pay more attention to the safety of credit funds, that is, the fact of default risk than profit maximization. In this paper, corporate default is included in the lending standard, and different credit default risk preference of commercial banks for SMEs is investigated. Third, based on the fact that there is a devaluation gap of mortgage assets before and after default, this paper examines the impact of different asset devaluation of SMEs on commercial bank lending.

The paper is organized as follows. In Section 2, the basic DSGE model is described, including heterogeneous economic sectors such as enterprise sector, household sector, final product sector, and central bank. In Section 3, the debt contract and the stability analysis between enterprises and commercial banks are described in detail. In Section 4, numerical simulation is introduced. In Section 5, the main conclusions are summarized.

2. Statement of Background

At present, the mainstream monetary policy model adopted by western developed countries is the new Keynesian DSGE model. It is based on the core of RBC model and constructed by introducing various Keynesian economic assumptions. Some scholars also call it new neoclassical synthesis [22]. Since the research published by Kydland and Prescott [23] and Prescott [24], Real Business Cycle (RBC) theory provides a standard research framework for economic cycle analysis and modern macroeconomic theory research. The new Keynesian model is established and developed on the basis of the RBC model; therefore, the many similarities between the New Keynesian model and RBC model are as follows: First, the representative family lives indefinitely and
chooses consumption and labor to pursue utility maximization under the condition of intertemporal budget constraints. Second, there are a large number of enterprises with the same technology, and they are all impacted by external technology. Third, consistent with the RBC theory, the equilibrium state of the model is represented as a random process of endogenous variables consistent with the most intertemporal behaviors of households and firms and with market clearing conditions.

However, there are many differences between the new Keynesian model and the RBC model in theoretical assumptions, the most important of which can be summarized as follows: First is the monopoly competition hypothesis. In contrast to the market clearing hypothesis of the neoclassical Walras auctioneer, the new Keynesian theory holds that the prices of goods and factors of production are determined by the optimal behavior of private sector agents. Second is the nominal viscosity hypothesis. Firms face costs when adjusting output prices and workers when adjusting wages, so nominal variables cannot immediately adjust to market clearing levels. Third is the short-term, nonneutral assumption of monetary policy. Due to the existence of the nominal stickiness hypothesis, short-term nominal price changes will not lead to a 1:1 change in expected inflation, which enables monetary policy to have an impact on the real interest rate in the economy, thus leading to corresponding fluctuations in consumption, investment, output, and employment. But, in the long run, all wages and prices will adjust and the economy will eventually return to equilibrium.

In the current study, there are two main methods of empirical research on the effectiveness of monetary policy. One is the vector autoregression (VAR) model represented by Sims [25], Bernake and Blinder [26]. As soon as the model was put forward, it was praised by many economists for its simple structure and good predictive ability, and it was widely used. However, the effectiveness of the VAR model has also been criticized—some researchers hold that the VAR model lacks strict theoretical basis, while others consider that there is only a relatively limited amount of information in the model due to the limited data conditions [27, 28]. The other one, which is widely used in monetary policy analysis and adopted by many central Banks, is the DSGE model. With the continuous improvement of economists, the matching degree of the DSGE model with the real economy has been greatly enhanced. For example, Christiano et al. [29] introduced a large number of frictions including sticky wage and price, habit preference, investment adjustment cost, and capacity utilization rate. A large number of studies have proved that the DSGE model can not only fit macroeconomic data well but also perform well in out of sample prediction, even better than traditional econometric models [16]. Based on the research of Christiano et al. [16] and Qiu and Zhou [30], and combined with the theoretical model constructed in our research, this paper proposes the following research hypothesis, and all the other assumptions are basically the same as those in the traditional DSGE model:

**Hypothesis 1.** In order to characterize limited banks’ risk preference for SMEs, this paper divides enterprises into two types: large enterprises (proportion 1 − η) and SMEs (proportion η).

**Hypothesis 2.** In order to match the two types of enterprises, this paper assumes that commercial banks are divided into two types: A and B. Type A commercial banks provide loans to large enterprises, and type B commercial banks provide loans to SMEs.

**Hypothesis 3.** The traditional DSGE model introduces capacity utilization to investigate the debt contract between capital production departments and banks. Considering that small and medium-sized enterprises (especially individual industrial and commercial households) have weak capital production capacity and are mostly engaged in the production of intermediate goods, which is different from the traditional DSGE model assumption, this paper uses the Douglas production function to investigate the relationship between intermediate goods sector and interbank credit activities.

In order to explain the basic model constructed in our study more clearly, the setting logic of the main departments in the theoretical model is shown in Figure 1:

### 2.1. The Household Sector

Assuming that there are a large number of families with homogeneous and indefinite periods in the economy, each family chooses to consume, provide labor, and save under budget constraints to maximize intertemporal utility. The lifetime utility function faced by a family is as follows:

$$\max E_0 \sum_{t=0}^{\infty} \beta_t U(c_t, n_t),$$

where $E_0$ is an expectation operator; $\beta_t \in (0, 1)$ represents subjective discount factor; $c_t$ and $n_t$ are the actual household consumption and the labor provided during the period $t$, respectively; and $U(\cdot)$ is the immediate utility function of the family. Without loss of generality, the immediate utility function is

$$U = \left(\frac{c_t - bc_{t-1}}{1 - \sigma} + \frac{n_t^{1-\varphi}}{1 - \varphi}\right),$$

where $\sigma$ and $\varphi$ are the reciprocal of the intertemporal substitution elasticity of household consumption and the elasticity of labor supply, respectively.

The family is bound by

$$i_t + c_t + d_t = w_t n_t + r_{t+1} k_{t+1} + \frac{i_{t+1}^d d_{t+1}}{\pi_t} + \Pi_t,$$

where $i_t$ is the interest (or savings); $d_t$ is the financial assets for residents (simplified as bank deposits); $w_t$ is the wage; $r_{t+1}^d$ is the capital rent; $k_{t+1}$ is the ending capital stock; $\pi_t$ is the nominal deposit rate; $\Pi_t$ is the inflation rate; $\Pi_t$ is the profits from companies and banks in the period $t$.

Capital accumulation equation is
where $\delta$ is the capital depreciation rate. The optimal behavior decision of the household sector is the optimal choice of consumption $c_t$, labor $n_t$, capital stock $k_t$, and savings $d_t$ under the constraints of household budget and capital accumulation equations. Therefore, the first-order condition of this optimization problem is as follows:

$$
\frac{(c_t - b c_{t-1})^\sigma}{(1 - b)^\sigma} - \beta b \frac{(c_{t+1} - b c_t)^\sigma}{(1 - b)^\sigma} = \lambda_t,
$$

$$
\lambda_t w_t = n_t^\delta,
$$

$$
E_t \left( \rho^{\lambda_{t+1}} (1 - \delta) \right) = \lambda_t,
$$

$$
E_t \left( \beta \lambda_{t+1} (1 - \delta) + r_{t+1}^k \right) = \lambda_t.
$$

where $\lambda_t$ is, respectively, the Lagrange multiplier corresponding to the constraints of household budget, while $\lambda_t$ is actually the marginal utility of wealth.

### 2.2. The Business Sector

#### 2.2.1. SMEs

Let the production function of SMEs be the Cobb–Douglas form:

$$
y_t^{xw} = A_t^{xw} k_t^{xw-1} (s) \alpha n_t^{xw} (s) \beta (1 - \alpha),
$$

where $y_t^{xw}$ is the $s_{th}$ type intermediate product; $k_t^{xw}$ is the capital used to produce intermediate products; $n_t^{xw}$ is the labor used to produce intermediate products; $\alpha$ and $1 - \alpha$ are the elasticity of output with respect to capital and labor, respectively; $A_t^{xw}$ represents the technological level, that is, the productivity of SMEs, which satisfies the condition that technological shocks obey the process $AR(1)$.

At the beginning of the period $t$, the SMEs determined the scale of production, and obtained loans from banks. Then, SMEs employ labor $n_t^{xw}$ and lease capital $k_{t-1}^{xw}$ with own net assets and loans for productions. The impact capability of SEMs is relatively weak, assuming that the returns realized by SMEs during each period would encounter a heterogeneous and uncertain impact $\omega_t^{xw}$, and $\ln(\omega_t^{xw}) \sim N(-\sigma^2/2, \sigma^2)$. This shock makes SMEs’ future earnings uncertain, thus converting the original earnings into effective earnings $\omega_t^{xw} y_t^{xw} (t)$; at the end of the period $t$, after the SMEs sell the current products to obtain production returns, the bank principal and interest are repaid.

Suppose a standard debt contract is signed between the SME and the bank, that is, a contract specifying the loan interest rate and loan amount: $(l_{t-1}^{xw} k_{t-1}^{xw})$, where $l_{t-1}^{xw}$ is the SMEs’ loan interest rate; $k_{t-1}^{xw}$ is the SMEs’ loan amount. At this time, the total investment of SMEs for production is

$$
w_t n_t^{xw} (s) + r_{t-1}^k k_{t-1}^{xw} (s) = l_t^{xw} + N_t^{xw}.
$$

The left side of (7) indicates the production scale determined by the SME at the beginning of the period, that is, the production input (cost); $l_t^{xw} = \frac{\omega_t^{xw} y_t^{xw} (s) + r_{t-1}^k k_{t-1}^{xw} (s)}{w_t n_t^{xw} (s) + r_{t-1}^k k_{t-1}^{xw} (s)}$ represents the loan received by the SMEs from the bank at the beginning of the period $t$, where $k_{t-1}^{xw}$ represents the proportion of bank loans in the production investment of SMEs, which can be regarded as the leverage ratio of SMEs’ external financing; $N_t^{xw} = (1 - k_{t-1}^{xw}(l_t^{xw}))l_t^{xw}$ represents the net assets of SMEs at the beginning of the period $t$.

The return on production of SMEs can be expressed as

$$
1 + R_t^{xw} (s) = \frac{\omega_t^{xw} y_t^{xw} (s)}{w_t n_t^{xw} (s) + r_{t-1}^k k_{t-1}^{xw} (s)},
$$

where $R_t^{xw} (s)$ indicates the input-output ratio of the $s_{th}$ SME.

Intermediate product manufacturing companies determine the proportion of factor demand through cost minimization. Given the final demand, by choosing $n_t^{xw} (s)$ and $k_{t-1}^{xw} (s)$ to minimize the cost in the production process, namely,

$$
\min_{n_t^{xw} (s), k_{t-1}^{xw} (s)} \left[ w_t (1 + \psi_s n_t^{xw} r_t^{xw}) n_t^{xw} (s) + r_{t-1}^k (1 + \psi_s k_{t-1}^{xw} r_t^{xw}) k_{t-1}^{xw} (s) \right],
$$

where $\psi_s^{xw}$ represents the proportion of wages which the enterprise has to pay before production; $\psi_s^{xw}$ represents the proportion of rent that the enterprise has to pay before production; $\psi_s^{xw}$ is a large enterprise SME; $\psi_s^{xw}$ is an intermediate enterprise; SMEs.
Thus, it can be further obtained that the actual marginal cost of per unit product produced by an intermediate product enterprise is
\[
mc_t^{xz} = \left[ t_k^{1 + \psi_k^{xz} r_{itz}^{xz} k_{-1}^{xz}} \right] a
\cdot \left[ w_t^{1 + \psi_n^{xz} r_{itz}^{xz}} \right]^{1-a} (1-a)^{-1} (A_t^{xz})^{-1}. \tag{11}
\]

2.2.2. Large Enterprises. Similar to small and medium-sized enterprises, at the beginning of the period \(t\), large enterprises determine the scale of production, obtain loans from banks, which is used to hire workers and purchase the capital required for production; compared with SMEs, large and medium-sized enterprises have a certain amount of assets that can be used for bank loan mortgages. Even in the event of corporate default, banks can protect their income by processing mortgaged assets. Thus, this article assumes that there is no default for large and medium-sized enterprises. Therefore, the scale of loans available to large enterprises is
\[
w_t^{i_t} N_t^{dz} = \left[ t_k^{1 + \psi_k^{d} r_{itz}^{d}} k_{-1}^{dz} \right] (1-a) a (1-a)^{-1} (A_t^{dz})^{-1}. \tag{12}
\]
where the left side of (12) is the total production input of the large enterprises at the beginning of the period \(t\); the first item on the right side of (12) is the loan of the large enterprises at the beginning of the period \(t\), \(k_{-1}^{dz} = k_{-1}^{dz} [w_t^{i_t} N_t^{dz} (s) + r_t^{1} k_{-1}^{dz}]\), where \(k_{-1}^{dz}\) represents the proportion of bank loans in the production investment of large enterprises and \(N_t^{dz} = (1 - k_{-1}^{dz} / k_{-1}^{dz})l_t^{dz}\) represents the net assets of large enterprises at the beginning of the period \(t\).

Given the final demand, by minimizing the cost, the capital-labor ratio of all intermediate goods enterprises for large enterprises can be obtained as
\[
k_{dz}^{i_t} = a \frac{w_t^{1 + \psi_n^{d} r_{itz}^{d}}}{1-a} \left[ t_k^{1 + \psi_k^{d} r_{itz}^{d}} \right]^{1-a} (1-a)^{-1} (A_t^{dz})^{-1}. \tag{13}
\]
From (13), it can be further obtained that the actual marginal cost of per unit product produced by an intermediate product enterprise is
\[
m_{dz}^{i_t} = \left[ t_k^{1 + \psi_k^{d} r_{itz}^{d}} \right] a \left[ w_t^{1 + \psi_n^{d} r_{itz}^{d}} \right]^{1-a} (1-a)^{-1} (A_t^{dz})^{-1}. \tag{14}
\]

Regarding the debt contract between large enterprises and banks, based on the high default rate of SME credit, this article assumes that there is no default situation for large and medium-sized enterprises. At this time, the conditions for large and medium-sized enterprises to meet the loan are
\[
\left( 1 + k_{dz}^{i_t} \right) [w_t^{i_t} N_t^{dz} (s) + r_t^{1} k_{-1}^{dz} (s)] - (1 + r_t^{dz}) N_{t}^{dz} = \left( 1 + \lambda_{dz} \right) (1 + r_t^{dz}) N_t^{dz}, \tag{15}
\]
where \(\lambda_{dz}\) represents the extra profit required by large companies compared to the profit margin obtained by depositing net assets in banks; the left side of (15) is the gains from large and medium-sized companies’ production in the period \(t\); the right side of (15) is the opportunity cost of large and medium-sized companies’ production.

2.3. Determination of the Optimal Price for the Enterprise. Since the market for intermediate products is in a state of monopolistic competition, manufacturers of intermediate products have certain pricing power for intermediate products under demand constraints. Suppose that the \(1 - \theta\) percent of intermediate goods manufacturers adjust prices; at this time, under the condition of demand constraints, the intermediate goods company can maximize profit by selecting the optimal intermediate goods price, and its behavior equation can be expressed as
\[
\max_{p_{t}} \left\{ \sum_{k=0}^{\infty} \left[ (\beta^{k} u_{t+k}^{y_{t+k}^{j}} - m_{t+k}^{dz} p_{t+k}^{j}) y_{t+k}^{j} (s) \right] \right\}, \tag{16}
\]
where \(\beta\) is the discount rate of intermediate product manufacturers. Since the manufacturers produce on behalf of residents, the discount rate is equal to the discount rate used by residents; \(u_{j}\) is the marginal utility of wealth; \(j\) takes \(dz\) and \(xw\) separately, indicating large enterprises and SMEs. \(p_{t}^{a_j} (s) = p_{t}^{* j} (s) (\pi_{t+1}^{j}, \ldots, \pi_{t+k}^{j})\) represents the relative price of the product of the \(s\) type of intermediate enterprise; \(y_{t+k}^{j} (s) = \left( s (p_{t+k}^{j} (s) / p_{t+k}^{j}) \right)^{1/(1-\epsilon)}\) represents the \(s\) type of intermediate products produced by the enterprise; \(y_{t+k}^{j}\) represents the final product produced by the enterprise; \(p_{t+k}^{j} (s)\) represents the optimal solution. By solving (16), the optimal pricing of intermediate goods manufacturers is
\[
E_t \sum_{k=0}^{\infty} \left\{ \frac{(\beta^{k} u_{t+k}^{y_{t+k}^{j}} (s))}{\epsilon p_{t+k}^{* j} (s)} p_{t+k}^{j} (s) \pi_{t+1}^{j}, \ldots, \pi_{t+k}^{j} (s) \right\} - (1 + \epsilon) m_{t+k}^{dz} p_{t+k}^{j} (s) = 0. \tag{17}
\]

From (18), the new Keynesian Phillips curve (logarithmic linearized form) is derived:
\[
\tilde{\pi}_{t}^{j} = \beta E_t \tilde{\pi}_{t+1}^{j} + \frac{(1 - \theta) (1 - \beta^{j})}{\theta^{j}} (m_{t+k}^{dz} - p_{t+k}^{j}), \tag{19}
\]

\(E_t\) is the expectations of an enterprise at the beginning of period. The discount rate and parameters are all positive. Then the classical Phillips curve can be obtained under the condition of \(\epsilon = 1\).
where $\hat{y}_i$ and $\hat{c}_i$ denote the deviation of inflation and real marginal cost of SMEs from their steady states, respectively; $p_i^j$ represents the relative price of SME product prices relative to final consumer goods. Then, we get

$$\hat{y}_i - \hat{c}_i = p_i^j - p_{i-1}^j. \quad (20)$$

2.4. End Product Manufacturer. The manufacturer that produces the final product processes the intermediate product into a final product and provides it to other economic entities. Assuming that the intermediate products are continuously distributed in the interval $[0, 1]$, the manufacturer that produces the final product uses the following production technology:

$$Y_t = \eta_Y (1/\eta_Y) (Y_{xw} + (1 - \eta_Y)(Y_{dz})^{(1/\eta_Y)}), \quad (21)$$

where $\eta_Y$ represents the elasticity of products substitution between SMEs and large and medium-sized enterprise in the final product synthesis; $\eta$ indicates the proportion of SMEs and large and medium-sized enterprises in the synthesis of products. From the profit maximization condition, the demand function of the final product manufacturer is

$$Y_{xw}(s) = \eta_Y (P_{xw}^s) Y_t, \quad Y_{dz}(s) = (1 - \eta_Y)(P_{dz}^s) Y_t. \quad (22)$$

Since the deal of final product manufacturer in a perfectly competitive market, its profit is zero and thus we can obtain

$$1 = \eta_Y (P_{xw}^s)^{1+\eta_Y} + (1 - \eta_Y)(P_{dz}^s)^{1+\eta_Y} \left[1^{1/\eta_Y+1} \right] \quad (23)$$

2.5. Central Bank and Market Clearing. Central banks usually focus on inflation and output gaps. The equations of monetary policy that follow the Taylor rule are

$$\tau_t^d = \left(\tau_{t-1}^d\right)^{\rho_{mm}} \left[\rho_{m} \left(\frac{\pi_{t+1}}{\pi} \right)^{\xi} (\frac{Y}{\bar{Y}})^{\xi} \right] \left[1^{1-\rho_{mm}} \right] u_t, \quad (24)$$

$$u_t = \phi_m u_{t-1} + \varepsilon_t,$$

where $\tau_t^d$, $\pi$, and $\bar{Y}$ represent the steady-state nominal interest rate, inflation, and output, respectively; $\rho_{mm}$ reflects the smoothness of the interest rate; and the bigger $\rho_{mm}$ is, the greater the persistence of an external shock to interest rates will be; $\xi$, and $\xi_{\bar{Y}}$ are response coefficients of inflation and output gap to the rate of monetary growth, respectively; $u_{m,t}$ expresses monetary policy shocks.

When the model is in equilibrium, all markets are cleared. Market equilibrium includes product market, capital market, labor market, and credit market equilibrium. According to Walras’ rule, only three of these market equilibriums are required.

Product market clearing: $y_t = c_t + i_t$;

Credit market clearing: $l_{ct}^d + l_{dz}^d = l^d$, that is, corporate credit demand equals bank credit supply;

Labor market clearing: $n_t^sw + n_t^dz = n_t$, that is, the labor demand of an enterprise is equal to the labor supply of residents.

There are three external shocks in the model economy: monetary policy shocks and production technology shocks for large enterprises and SMEs. They satisfy the standard first-order autoregressive equations. The specific form is

$$\ln z_t = (1 - \rho_z) \ln z + \rho_z \ln z_{t-1} + \varepsilon_{zt}, \quad (25)$$

where $\rho_z$ reflects the degree of impact inertia and $\varepsilon_{zt}$ reflects external shocks, satisfying $N(0, \sigma_z^2)$ and $i \in (u, a_{sw}, a_{dz})$.

3. Main Results

Following Dib [31], Peng and Fang [32], there are two types of homogeneous commercial banks, namely, A and B in the model, which provide loans to large enterprises and SMEs, respectively. There is no default risk when commercial banks lend to large enterprises. But, there is default risk when they provide short-term loans to SMEs.

When the SMEs’ credit defaults, the commercial bank has the right to dispose of the remaining property of the SME. Because of information asymmetry, commercial banks do not know the real state of capital gains. Therefore, there is a cost to identify the state. This paper assumes that the regulatory cost that financial institutions needs to pay is $\mu$ percent of the total profit ratio paid by enterprises to commercial banks as the proportion of assets lost by banks after bankruptcy and liquidation. When the monitoring cost $\mu$ increases, the mortgage rate $\omega$ rises. Different from previous research, this paper sets $\sigma_{aw}$ to measure the depreciation of corporate assets after default. When the $\sigma_{aw}$ increases, the mortgage rate decreases.

In reality, large enterprises with large asset scale and good credit often prioritize the credit resource allocation of commercial Banks. However, SMEs are more likely to default when their production activities are impacted by external risks; as a result, the security of bank credit funds decline, resulting in the reluctance to lend to SMEs. In order to describe commercial banks’ consideration about SMEs’ default rate and net assets in loans, this paper sets $\lambda_f$ and $\lambda_n$ to measure commercial banks’ sensitivity to SMEs’ default rate and net assets risk preference, respectively. When the $\lambda_f$ is high, it indicates that commercial Banks pay more attention to the default rate of SMEs in loans. When the parameter $\lambda_n$ is high, it indicates that commercial banks pay more attention to the net assets of SMEs in lending.

3.1. Debt Contract between Enterprise and Commercial Banks.

Due to information asymmetry, banks do not fully grasp the heterogeneous and uncertain impacts, production conditions, and investment returns faced by SMEs, so it is costly to identify these situations. Suppose that the bank only knows the distribution of $\omega_{sw}^a$ in advance; the actual value of the audit $\omega_{sw}^a$ needs to pay the monitoring cost equivalent to the
\( \mu \) percent of the total revenue for the enterprise, that is, 
\( \mu \omega^x_w = \omega^x_w [r_t (1 + r_{t, xw}^l) n_t^x (s) + r^k_t (1 + \psi_k r_{t, xw}^l) k_{t-1}^x (s)] \).

The arrangements for debt contracts signed by banks and entrepreneurs are as follows: the nondefault interest rate for entrepreneur loans \( r_{t, xw}^l \) is \( r_{t, xw}^l \); it depends on the critical value \( \omega^x_w \) of the random variable \( \omega^x_w \), namely,
\[
\omega^x_w (1 + R^k_{t, xw}) = \left( 1 + r_{t, xw}^l \right) \omega^x_w (s).
\]

When \( \omega^x_w \leq \omega^x_w \), SMEs repay principal and interest of commercial banks \( (1 + r_{t, xw}^d) \omega^x_w \), and earn income \( \omega^x_w \).

Different from the assumption of SMEs, large companies do not have credit defaults. When loans are due, the principal and interest of commercial banks can be guaranteed. Therefore, commercial banks can obtain from large enterprise loans as \( (1 + r_{t, dz}^d) \omega^x_w (s) \).

Unlike Bernanke et al. [15] and other scholars who set up complete competition for commercial banks, this article is based on the character of China’s bank-led financial system, in which commercial banks have a high degree of monopoly and draw on the design of Qiu and Zhou [30]. In the model, suppose that commercial banks have the ability to monopolize bargaining power in the process of SMEs’ crediting, and therefore \( \omega^x_w \) are endogenous, depending on the commercial banks’ decision to maximize profits. Therefore, suppose that the commercial banks are in a monopolistic competitive market. Then, the commercial Banks in the model are in the monopolistic competition market, and the aggregate loan demand for each type of bank faces \( b_{t, dz}^y = \left \{ \int_0^{r^y_t} f_{t, dz}^y (s) \phi_t (s) ds \right \} \), where \( \phi_t (s) > 1 \) is the elasticity of substitution between commercial banks. Let loan interest rate index be \( r^d_t = \left \{ \int_0^{r^y_t} (s) \phi_t (s) ds \right \}^{-1} \), then the loan demand of commercial bank is \( b_{t, dz}^y = \left \{ (r^y_t(s))^{-1} \right \} \).

So the decision problem of the \( s_{th} \) commercial bank is
\[
\max_{r_{t, xw}, \omega_{t, xw}, r_{t, dz}} [1 - F(\omega^x_w)](1 + r_{t, xw}^l) \omega^x_w (s) + (1 - \mu) \sigma^x_w \int_{\omega^x_w}^{\infty} \omega^x_w dF(\omega^x_w) \omega^x_w \left( 1 + R^k_{t, xw} \right)
\]

\[
\left[ \omega^x_w (1 + r_{t, xw}^l) n_t^x (s) + r^k_t \left( 1 + \psi_k r_{t, xw}^l \right) k_{t-1}^x (s) \right] + \left( 1 + r_{t, dz}^d \right) \omega^x_w (s) - \left( 1 + r^d_t \right) \omega_{t, xw},
\]

where \( j \) gets \( xw \) and \( dz \), representing two types of SMEs and large enterprises, respectively.

Commercial banks choose the loan interest rates of large enterprises and SMEs, and SME mortgage rates to maximize their profits, so that they can get
\[
1 + r_{t, xw}^l = \frac{\theta^x_w (1 + r^d_t)}{(\theta^x_w - 1) [1 - F(\omega^x_w)]},
\]

\[
\frac{1 - F(\omega^x_w)}{\theta^x_w} - [1 - \sigma^x_w (1 - \mu)] \omega^x_w F'(\omega^x_w) = 0.
\]
Table 1: Parameter calibration.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma^{wu}$</td>
<td>SMEs’ capital output elasticity</td>
<td>0.45</td>
</tr>
<tr>
<td>$\sigma^{dz}$</td>
<td>Elasticity of capital output of large enterprises</td>
<td>0.6</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.9936</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
<td>0.0525</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Reciprocal household consumption elasticity</td>
<td>2</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>Reciprocal of labor supply elasticity</td>
<td>1</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Price stickiness</td>
<td>0.8</td>
</tr>
<tr>
<td>$\eta$</td>
<td>SMEs’ intermediate products account for the proportion of final products</td>
<td>0.28</td>
</tr>
<tr>
<td>$\epsilon^{wu}$</td>
<td>SME middleware substitution elasticity</td>
<td>3</td>
</tr>
<tr>
<td>$\epsilon^{dz}$</td>
<td>Intermediate substitution elasticity of large enterprises</td>
<td>1</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Banks’ proportion of credit monitoring costs</td>
<td>0.12</td>
</tr>
<tr>
<td>$\gamma^{wu}$</td>
<td>SME credit interest rate flexibility</td>
<td>132.7</td>
</tr>
<tr>
<td>$\gamma^{dz}$</td>
<td>Large enterprise credit interest rate flexibility</td>
<td>137.5</td>
</tr>
<tr>
<td>$\rho_m$</td>
<td>Monetary policy smoothing factor</td>
<td>0.38</td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>Autoregressive coefficient</td>
<td>0.95</td>
</tr>
</tbody>
</table>

elasticity of the SME loan interest rate and the critical value of the external risk. This article describes the risk preference of commercial banks for SMEs’ default rate and net asset status through the following formula:

$$
\delta_i^{wu} = \delta^{wu} \exp \left[ \lambda_n \left( \frac{N_i^{wu}}{N_i^{wu} - 1} \right) - \lambda_f \left( \frac{F(\alpha^{wu})}{F(\alpha^{wu}) - 1} \right) \right] \quad (32)
$$

where $\lambda_n$ reflects the sensitivity between SMEs’ own net assets and loan demand elasticity; $\lambda_f$ reflects the sensitivity between SMEs’ default rate and loan demand elasticity; $\lambda_n > 0$ and $\lambda_f > 0$.

3.2. Stability Analysis. Based on the description of each economic sector in the model, the behavior of each major economic entity is analyzed from the perspective of optimization. The decision equation of the loan contract between SMEs and commercial banks is

$$
\left[ 1 - F(\alpha^{wu}) \right] \frac{\delta_i^{wu}}{\delta_i^{wu}} - \left[ 1 - \sigma^{wu} (1 - \mu) \right] \omega_i^{wu} \exp \left( \frac{F(\alpha^{wu})}{F(\alpha^{wu}) - 1} \right) = 0 \quad (33)
$$

From the calculation of MATLAB, it can be seen that the mortgage rate of commercial banks to SMEs is negatively correlated with the elasticity of commercial banks’ loan interest rates to SMEs. That is $(\partial \alpha^{wu}/\partial \delta_i^{wu}) < 0$, as the elasticity of bank loan interest rates $\delta_i^{wu}$ increases, the mortgage rate $\alpha^{wu}$ of SMEs’ loans will become smaller. In addition, the elasticity of loan interest rates for commercial banks to SMEs is positively related to the depreciation of corporate net assets when SMEs fail. That is $(\partial \alpha^{wu}/\partial \sigma^{wu}) > 0$ as the elasticity of bank loan interest $\sigma^{wu}$ increases, the mortgage rate of SMEs’ loans will become bigger.

In addition, the decision equation of commercial banks’ loan interest rates for SMEs is:

$$
1 + r_f^{wu} = \frac{\delta_i^{wu} \left( 1 + r_e^d \right)}{\left( \delta_i^{wu} - 1 \right) \left[ 1 - F(\alpha^{wu}) \right]} \quad (34)
$$

From (34), the interest rate of commercial bank loans to SMEs is also negatively related to the elasticity of commercial bank loan rates to SMEs, that is $(\partial r_f^{wu}/\partial \delta_i^{wu}) > 0$, as the elasticity of bank loan interest rates increases, the interest rate of commercial banks’ loans to SMEs decreases.

In addition, this paper introduces the mechanism of the impact of commercial banks’ default on SMEs’ net assets and loans, that is, by changing the elasticity of loan demand, the loan interest rate, and mortgage interest rate of commercial banks will be affected.

The risk preference equation of a commercial bank is

$$
\delta_i^{wu} = \delta^{wu} \exp \left[ \lambda_n \left( \frac{N_i^{wu}}{N_i^{wu} - 1} \right) - \lambda_f \left( \frac{F(\alpha^{wu})}{F(\alpha^{wu}) - 1} \right) \right] \quad (35)
$$

From (35), the correlation between the elasticity of loan interest rates for commercial banks to SMEs and the net assets of enterprises depends on the parameters $\lambda_n$. When $\lambda_n > 0$, $(\partial \alpha^{wu}/\partial N_i^{wu}) > 0$, the larger the net assets of the enterprise, the greater the elasticity of the loan interest rate of commercial banks. The correlation between the elasticity of loan interest rates of commercial banks to SMEs and the default rate of enterprises depends on the parameters $\lambda_f$. When $\lambda_f > 0$, $(\partial \alpha^{wu}/\partial (\alpha^{wu})) > 0$, the higher the corporate default rate, the greater the elasticity of commercial bank loan interest rates.

Based on the risk preference of commercial banks for corporate net assets and their aversion to corporate defaults when lending to enterprises, this paper sets $\lambda_n > 0$ and $\lambda_f > 0$. Through the above static comparison analysis among the interest rate determination equation, loan contract and risk preference equation of commercial bank, corollaries are derived as follows:

**Corollary 1.** The smaller the tolerance of commercial banks for default of SMEs, the smaller the size of loans available to SMEs.

**Corollary 2.** The greater the sensitivity of commercial banks to the size of SMEs’ net assets, the larger the scale of loans available to SMEs.
Corollary 3. The higher the quality of SMEs’ net assets, the larger the scale of SMEs’ bank loans.

4. Numerical Simulation Analysis

In this part, this article performs numerical simulation calculation on the above DSGE model. In order to examine the credit allocation of SMEs under different risk preferences of commercial banks, we use the calibration method to obtain model-related parameters and then use the model steady-state equation and numerical simulation to analyze the changes in the dynamic adjustment process when the model steady-state and endogenous variables face the impact of exogenous monetary policy under different parameter settings.
4.1. Model Parameter Calibration. This paper uses the macro- and microeconomic data of the National Bureau of Statistics and the steady-state equation of the model to obtain the model parameter values. The model calibration process mainly uses the average value of macro- and microeconomic data that can be observed in reality to calculate the model parameter value through the steady-state equation of the nonlinear model. The sample period of macro and micro is 1998Q1-2018Q4. The economic variables involved in this paper, such as real GDP, real m2, CPI, and so on, and the data of SME loans and large-scale enterprise loans are all from Wind database.

Table 1 shows the specific information on parameter calibration. From the average value of the one-year deposit interest rate of 2.57%, the calibration result of the subjective discount factor $\beta$ for residents is 0.9936. Referenced Peng and Fang [32], the reciprocal elasticity of household consumption substitution $\sigma$, labor supply elasticity $\varphi$, and the price stickiness parameter $\mu$ are set 2, 1, and 0.8, respectively. According to estimates by Lin and Yang [33], the elasticity of capital output for large enterprises and SMEs are 0.6 and 0.45, respectively. The cost $\mu$ of bank monitoring for SMEs’ loans is 0.12, which is commonly used in literature. The common reference value of capital depreciation rate is 0.025. The substitution elasticity of intermediate goods for large enterprises and SMEs are set to 1 and 3. The large enterprise loan interest rate adopts the 1-year loan interest rate announced by the Statistics Bureau. According to the 2019 one-year loan interest rate issued by the People’s Bank of China was 6.07%. The steady-state values of corporate loan interest rate elasticity $\rho$ are 137.5 and 132.7, respectively. According to estimates by Qiu and Zhou [30], the smoothing factor $\rho_m$ for monetary policy is 0.38. The autoregressive coefficient $\rho_z$ is taken as 0.95. Calculated from the SME loan and large enterprise loan data in the Wind database, the combined proportion of the final product synthesis of large enterprise intermediate products and SME intermediate products is 0.28 and 0.72, respectively.

4.2. Numerical Simulation and Impulse Response. SMEs obtain loans from commercial banks through mortgaged net assets. When external risk shocks exceed the capacity of SMEs, they close down. At this time, commercial banks have

![Figure 3: Simulation results of commercial banks’ preference mechanism for the default risk of SMEs.](image-url)
the right to dispose for SMEs, thereby making up for credit losses. The reality is that when SMEs go bankrupt, when commercial banks auction the remaining net assets of SMEs, the remaining assets of SMEs after credit default often have a gap with the net assets pledged before the credit default. The larger the gap, the remaining will be the net assets after SMEs default. The stronger the depreciation of assets, the greater the credit losses of commercial banks. This article uses \( \sigma_{xw} \) to indicate the depreciation of the remaining net assets for SMEs after default. The smaller the \( \sigma_{xw} \), the more severe the depreciation.

\[
\text{Effective output} = \frac{\lambda_{n,f}}{1 - \mu} \left( \frac{\lambda_{n,f} F'(\omega_{xw})}{\sqrt{\omega_{xw}}} \right) \left( 1 - \frac{\lambda_{n,f}}{\sqrt{\omega_{xw}}} \right)
\]

Figure 4: Simulation results of commercial banks’ risk neutrality and different overall comparison.

The framework of tight monetary policy and the heterogeneity of enterprises, this article examines the impact of different risk preference of banks on SMEs’ credit financing. The main conclusion is: with the increase of interest rate by central bank, the credit financing of SMEs is suppressed. And, different risk preferences of commercial banks lead to different credit financing conditions of SMEs.

4.3. Influence of Different Parameter Settings on Impulse Response Function of Endogenous Variables. Under the framework of tight monetary policy and the heterogeneity of enterprises, this article examines the impact of different risk preference of banks on SMEs’ credit financing. The main conclusion is: with the increase of interest rate by central bank, the credit financing of SMEs is suppressed. And, different risk preferences of commercial banks lead to different credit financing conditions of SMEs.

Figure 2 analyzes the impact of the different weights for commercial banks’ risk preference on SMEs’ credit financing and effective output under the random impact of a positive interest rate of 10%. In the tight monetary policy cycle, the credit supply of commercial banks is tightened, corporate production activities are reduced, output is reduced, and corporate default risks are increased. Meanwhile, banks increase the inspection weight of corporate mortgage assets. From the risk preference equation of commercial banks, we get that when the assets of SMEs deviate from the steady-state value downward, the elasticity \( \varphi_{xw} \) of commercial banks’ credit interest rates on SMEs decrease. From the perspective of credit interest rate channels: when the \( \theta_{xw} \) decreases, the credit interest rate of SMEs increase and the cost of credit rise. From the perspective of risk-bearing channels: as the \( \varphi_{xw} \) decreases, the mortgage rate \( a_{t,xw} \) increases. The high mortgage rate
indicates that the enterprise’s sample assets can obtain more loans from the bank, and the cost of borrowing is reduced. From the pulse effect results of Figure 2, with central bank interest rate hikes, the rising cost of borrowing due to rising interest rates exceeds the falling cost of borrowing due to rising mortgage rates, and SME credit financing is suppressed, and the effective output declines. However, as the weight of commercial banks’ risk preference for SMEs’ net assets increased, the effect of lowering the cost of borrowing from the risk-taking channel exceeds the effect of the rising cost of borrowing from the interest rate channel. The downward deviation from the steady-state trend is suppressed.

Figure 3 analyzes the SMEs’ credit financing and effective output impact of the different weights of commercial banks on the default risk of SMEs under a positive interest rate impact. The high default rate of SMEs on bank credit has become an important reason restricting their credit. In the process of central bank interest rate hikes, the scale of bank credit has decreased, and the default rate has decreased. From the risk preference equation of commercial banks, it can be seen that as the default rate decreases, the $\lambda_{n,f}$ increases. From the perspective of interest rate channels: since the loan interest rate of SMEs is negatively correlated with the elasticity of credit interest rates, when the $\vartheta^{\text{sw}}$ increases, the loan interest rate decreases, and the cost of obtaining credit for SMEs decreases. From the perspective of risk-bearing channels: an increase in credit interest rates $\vartheta^{\text{sw}}$ leads to a reduction in the mortgage rate and an increase in the borrowing costs of SMEs. The impulse response of Figure 3 shows that in the tight monetary policy cycle, as commercial banks attach importance to SME defaults, the increase in parameters $\lambda_f$ has led to further increase in SME credit financing constraints, and effective output has further deviated from the steady-state trend.

For the sake of robustness, this paper tests the effectiveness of the risk preference mechanism of commercial banks from two aspects, and compares the simulation results. Specifically, it is obtained by assuming that the commercial banks are neutral ($\lambda_{n,f} = 0$) to the net asset value and default risk preference of SMEs and that the risk preference of commercial banks is different ($\lambda_{n,f} = 0.1, 0.5, 0.9$). Figure 4 shows the simulation results when the parameters of asset value and default risk preference of commercial banks change at the same time. Compared with that when commercial banks are neutral to the net asset value and default risk preference of SMEs, when commercial banks have risk preference, economic variables such as loan rate, loan mortgage rate, and loan rate elasticity...
will fluctuate in the short term. When $\lambda_{n,f} = 0.5$ and $\lambda_{n,f} = 0.9$, the simulation results are contrary, which may be caused by the substitution effect of monetary policy interest rate transmission channel and bank risk-taking transmission channel. However, it does not affect the effectiveness of the risk preference mechanism of commercial banks. Simulation results of different comparisons of commercial banks' risk preference based on the perspective of net asset value as shown in Figure 5. Simulation results of different comparison of risk preference of commercial banks based on default perspective as shown in Figure 6. The results show that, when commercial banks have risk preference, the economic variables of SMEs will fluctuate significantly in the short term, and the direction is opposite, which is consistent with the simulation results. This shows the effectiveness of the risk preference mechanism of commercial banks. Thus, the risk preference mechanism of commercial banks constructed in this paper can explain the credit financing problems of SMEs.

For the sake of robustness, the cases for $\lambda_n = 0$ and $\lambda_f = 0$ are investigated. When both $\lambda_n$ and $\lambda_f$ are zero, commercial banks only consider the effect of the interest rate channel. The results show that there is no significant relationship between the dynamic process of other variables and the risk taking channel, except the mortgage rate. With the introduction of the risk-bearing channel, the mortgage rate will take on different states with the different values of $\lambda_n$ and $\lambda_f$, and the commercial banks have different preferences for corporate net assets and default risk, thus affecting the financing constraints of SMEs.

5. Conclusion and Implication

By constructing a DSGE model with commercial banks' credit risk preferences, this paper examines the impact of different risk preferences of commercial banks on SME credit financing, and draws the following main conclusions: Firstly, from the perspective of high default rate of SMEs, this paper analyzes the depreciation gap of mortgage assets before and after default. The comparative static analysis of the theoretical model shows that with the increase of the devaluation of mortgage assets, the critical value of risk-taking of SMEs is reduced, and the borrowing cost is increased, so the loan scale and leverage ratio of SMEs are reduced, and the effective output is reduced. Secondly, this paper conducts numerical simulation of the theoretical model under the framework of the central bank’s interest rate hike and the assumption that the potential output of SMEs can be used as collateral. It is found that with the increase of the weight of commercial banks’ risk preference...
for corporate assets, the loan interest rate elasticity of commercial banks to SMEs decreases, and the reduction of the loan interest rate elasticity will lead to the increase of mortgage rate, the reduction of borrowing costs, the increase of loan scale and leverage ratio, and the increase of the effective output of SMEs. Thirdly, the study found that under the tightening monetary policy background, the increase in the weight of commercial banks’ default preference for SMEs leads to an increase in the elasticity of loan interest rates, a reduction in mortgage rates, a rise in borrowing costs, and reduced loan scale and effective output of SMEs. Therefore, reducing the information asymmetry between SMEs and commercial banks, improving the quality of net assets of enterprises, or expanding the scope of corporate collateral can increase the availability of credit financing for SMEs.

The research has the following implications for solving the problem of financing difficulty and high cost for SMEs: on the one hand, as the direct supplier of external financing for enterprises, financial intermediaries have different perceptions of asset quality and loan risk, which will directly affect their lending behaviors. Therefore, when the central bank has the policy tendency of directional lending to SMEs, commercial banks should moderately increase the tolerance of SMEs’ credit risk. On the other hand, financial innovation on loan collateral for SMEs should be carried out, thereby improving the grade of loan collateral or expanding the scope of loan collateral should be paid attention. However, it can only be used as an unconventional means of lending in a special period, which will increase the loan risk of commercial banks in the long run.

This study mainly investigates the transmission and implementation effect of commercial banks’ monetary policy on SME financing. In the future research, direct financing channels in capital market can be brought into the framework. Meanwhile, this study focuses on the theoretical research at the macro level, and further empirical studies can be conducted at the micro level to investigate the impact of commercial banks’ risk preference on SMEs’ financing.

Appendix

A. An Overview of the Model

In the process of constructing the dynamic stochastic general equilibrium (DSGE) model, based on the rational man hypothesis, this paper models the economic behaviors of household sector, enterprise sector, financial intermediary sector, and central bank sector in the economy. At the same time, the household sector should be satisfied with the maximization of lifetime utility, the enterprise sector should be satisfied with the maximization of corporate profits, and the corporate default rate should be considered under the profit-maximization framework when the financial sector signs debt contracts with enterprises. In addition, the monetary policy of the central bank follows the Taylor rule. After the above economic models are given, in order to obtain the optimal behavior of each economic sector, the first-order derivative of each economic sector behavior model is carried out. The following are the first-order conditions (FOC) of the main equations involved in each economic sector in the model, specifically:

A.1. The Household Sector

Combined with the household utility function model (1) and model (2), household utility constraint model (3), and capital accumulation equation model (4), the first-order conditions of consumption \( c_t \), labor \( n_t \), deposit \( d_t \), and capital \( k_t \) can be obtained as follows:

1. FOC on consumption

\[
\frac{(c_t - bc_{t-1})^\sigma}{(1 - b)^\sigma} - \beta (c_{t+1} - bc_{t+1})^{-\sigma} = \lambda_t; \quad (A.1)
\]

2. Wage pricing equation

\[
\lambda_t w_t = n_t^\rho; \quad (A.2)
\]

3. First-order terms for deposits

\[
\left( \frac{\lambda_{t+1}}{n_{t+1}} r_t^d \right) = \lambda_t; \quad (A.3)
\]

4. FOC for investment

\[
\beta \lambda_{t+1} [(1 - \delta) + r_{t+1}^k] = \lambda_t. \quad (A.4)
\]

A.2. The Enterprise Sector

Based on the intermediate product production function, model (6), cost constraint condition model (7) or (12), and under the minimum cost condition model (9), first-order conditions of input factors and actual marginal cost can be obtained by differentiating \( n_t \) and \( k_t \). According to the optimal price determining behavior of enterprises, with the optimal price determining equation (16) of enterprises, by taking the first derivative of the optimal price, the new Keynesian Phillips curve can be obtained. In addition, with the final manufacturer’s production function model (21) being given, the first-order conditions of enterprise input factors and the total price determination equation can be obtained. The details are as follows:

1. Capital factor input of SMEs

\[
(1 + \Psi^{xw}_k r_t^x) r_t^k k_{t-1}^{xw} = amc_t^{xw}; \quad (A.5)
\]

2. Labor factor input of SMEs

\[
(1 + \Psi^{xw}_n w_t) w_t n_{t}^{xw} = (1 - a) mc_t^{xw}; \quad (A.6)
\]

3. Actual marginal cost of SMEs

\[
mc_t^{xw} = \left[ r_t^k (1 + \Psi^{xw}_k r_t^x)^{\gamma} \right]^{1-a} \left[ w_t (1 + \Psi^{xw}_n r_t^x) \right]^{1-a}; \quad (A.7)
\]
(4) Return on production of SMEs

\[ 1 + R_t^{k, \text{SME}} = \frac{\omega_t^{x, \text{SME}} y_t^{x, \text{SME}}}{\omega_t^{x, \text{SME}} n_t^{x, \text{SME}} + r_t^{k, \text{SME}}}, \quad (A.8) \]

(5) Capital factor input of large enterprises

\[ (1 + \Psi_k^d r_t) r_t^k k_t^d = \text{amc}_t^{d, \text{SME}} y_t^{d, \text{SME}}), \quad (A.9) \]

(6) Labor factor input in large enterprises

\[ (1 + \Psi_k^d r_t) r_t^k k_t^d = \text{amc}_t^{d, \text{SME}} y_t^{d, \text{SME}}), \quad (A.10) \]

(7) Actual marginal cost of large enterprises

\[ \text{mc}_t^{d, \text{SME}} = \left[ r_t^k (1 + \Psi_k^d r_t) r_t^k k_t^d \right] \left[ u_t (1 + \Psi_k^d r_t) r_t^k k_t^d \right]^{1-a-a} \cdot (1-a)^{(1-a) - \left( \text{Amc}_t^{d, \text{SME}} \right)^{-1}}, \quad (A.11) \]

(8) Return on production of large enterprises

\[ 1 + R_t^{k, \text{SME}} = \frac{y_t^{d, \text{SME}}}{\omega_t^{x, \text{SME}} n_t^{x, \text{SME}} + r_t^{k, \text{SME}}}, \quad (A.12) \]

(9) The New Keynes Phillips curve

\[ \bar{\pi}_t^j = \beta E \bar{\pi}_{t+1}^j + \frac{(1-\theta)(1-2\beta)}{\theta} \left( \text{mc}_t^j - p_t^j \right); \]

\[ \bar{\pi}_t^j - \bar{\pi}_t = p_t^j - p_{t-1}^j; \quad (A.13) \]

\[ \text{A.3. The Debt Covenants between Enterprises and Commercial Banks} \]

Under the condition of considering the risk of corporate default, with the behavior equation of commercial banks in the paper (28) being given, combined with the constraint condition (27), mortgage rates in the commercial bank $\omega_t^{x, \text{SME}}$ and loan interest rates $r_t^d$ can be firstly differentiated, and the following FOC can be obtained:

(1) Marginal default conditions for SMEs

\[ \text{A.4. Other Conditions} \]

Based on the equilibrium and clearing of labor market, capital market, and financial market in the paper, the following equations can be obtained:
(1) Total resource constraint
\[ y_t = c_t + i_t; \]  
(A.24)

(2) Capital accumulation equation
\[ k_t = (1 - \delta)k_{t-1} + i_t; \]  
(A.25)

(3) Capital market clearing
\[ k^x_t + k^z_t = k_t; \]  
(A.26)

(4) Labor market clearing
\[ n^x_t + n^z_t = n_t, \]  
(A.27)

(5) Total credit scale
\[ l^x_t + l^z_t = l^b_t. \]  
(A.28)

Given the first-order conditions in the above paper, the model parameters can be calibrated by combining the existing relevant literature and the economic data over the years in China. After the model parameters are obtained, Matlab and Dynare software can be directly used to carry out editing operations so as to obtain the corresponding simulation results in the paper. Finally, the main data and programming code are given.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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