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Original Paper

A Study on the Causes and Optimization Paths of Rural Inclusive Financial Supply Constraints from the Perspective of Credit Rationing

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Abstract

This study, based on the theory of credit rationing, analyzes the causes of supply constraints in rural inclusive finance and constructs expected profit models for commercial banks, farmers, and guarantee institutions to explore their roles in rural financial supply. The research finds that factors such as information asymmetry, high difficulty in credit risk management, and an imperfect guarantee mechanism are the main reasons for the constraints on the supply of rural inclusive finance. Banks, concerned about default risks, adopt high interest rates and strict approval policies, which suppress the financing needs of farmers. Although guarantee institutions can alleviate credit rationing to some extent, their sustainability is challenged. In response to these issues, this paper proposes optimization paths, including improving the rural credit system, optimizing credit risk management, perfecting the guarantee mechanism, and reasonably setting loan interest rates. It emphasizes the need for coordinated efforts among the government, financial institutions, guarantee institutions, and borrowers to promote the improvement and development of the rural financial system through institutional innovation. The conclusions not only expand the application of credit rationing theory in the field of rural inclusive finance but also provide theoretical and practical guidance for policy-making.

Keywords

Rural Inclusive Finance, Credit Rationing, Supply Constraints, Optimization Paths

1. Introduction

The supply constraints of rural inclusive finance are an important factor restricting the development of China's rural economy. In recent years, with the advancement of the rural revitalization strategy, the rural financial service system has gradually improved, but there are still many problems on the supply side. Li et al. (2021) pointed out that the poverty reduction effects of rural inclusive finance vary across different regions. High-level areas have a significant poverty reduction effect, while low-level areas,

due to the "suction effect," have poor poverty alleviation results. Cheng and Li (2023) found that the development of digital inclusive finance has a significant role in narrowing the urban-rural consumption gap, but it may widen the urban-rural consumption gap in terms of usage depth, with regional differences in its effectiveness. Chen (2022) demonstrated through empirical research that digital inclusive finance promotes rural revitalization, but its impact varies structurally across different regions, with significant effects in the eastern and central regions, but not in the western region. The supply side of rural inclusive finance faces issues such as unbalanced regional development and low levels of digitalization, which affect its role in rural revitalization. Therefore, it is of great significance to deeply analyze the causes of supply constraints in rural inclusive finance and explore optimization paths to achieve high-quality rural economic development. This paper will examine the specific causes of supply constraints in rural inclusive finance from the supply side perspective, combined with regional differences, and propose corresponding optimization strategies to provide references for policy-making.

2. Theoretical Basis and Research Model

2.1 Theoretical Basis

The theory of credit rationing is an important theoretical basis for analyzing the supply constraints of rural inclusive finance. Stiglitz and Weiss (1981) pointed out in their classic credit rationing model that information asymmetry leads banks to attract high-risk borrowers when increasing loan interest rates, thereby increasing default risks and restricting credit supply. Bester (1985) further introduced collateral as a screening mechanism, arguing that banks can distinguish borrowers' risk types by requiring different levels of collateral to mitigate information asymmetry. Williamson (1986) discussed the role of monitoring costs in credit rationing, arguing that high monitoring costs make banks more inclined to ration credit to borrowers with severe information asymmetry. In the field of rural finance, information asymmetry and transaction costs are particularly prominent. Xu et al. (2022) introduced the distance of subjective and objective project success probabilities into the credit rationing model, constructing a theoretical model that explains the relationship between traditional rural finance and digital inclusive finance, and found that digital inclusive finance can alleviate information asymmetry in the rural credit market to some extent.

In summary, the theory of credit rationing provides important theoretical support for analyzing the supply constraints of rural inclusive finance. By deeply studying the impact of factors such as information asymmetry, collateral requirements, and monitoring costs on credit rationing, theoretical and practical guidance can be provided for optimizing the supply of rural inclusive finance and alleviating credit rationing.

2.2 Research Model

(1) Risk and Profit Analysis of Commercial Banks

In the field of rural inclusive finance, due to information asymmetry and high credit risks, banks must consider default risks when providing loans to small and micro enterprises. Assume that the bank issues a loan amount of L to the borrower at an interest rate of r; the probability of the borrower repaying on time under normal circumstances is (1–p), and the probability of default is p. If the borrower does not default, the bank will receive L(1 + r); if they default, the bank can only recover a certain proportion of the collateral or guarantee assets, denoted as C. Here, C < L(1 + r). Therefore, the expected profit of the bank can be expressed as:

$E(bank) = (1–p) * [L(1 + r)] + p * C – L$

Here, $L(1 + r) – L = rL$ represents the pure profit without default; if there is a default, the profit is C – L. Thus, the above equation can also be written as:

$E(bank) = (1–p) * rL + p * (C – L)$

The probability of default p is usually affected by the loan interest rate r, so the function p = p(r) is constructed. The reason is that increasing the interest rate may attract high-risk borrowers and increase the default rate (i.e., adverse selection effect). Moreover, information asymmetry is particularly severe in rural areas, making banks bear higher default risks.

The goal of bank operations is to choose the optimal loan interest rate r to maximize its expected profit E(bank). Considering that p is a function of r, the optimal problem of the bank's expected profit can be expressed as:

$\text{Maximize } E(bank) = (1–p(r)) * rL + p(r) * (C – L)$

To find the optimal r, the first-order derivative of r is required and set to zero. Let F(r) = E(bank), then:

$F(r) = (1–p(r)) * rL + p(r) * (C – L)$ (1)

Taking the derivative of r, we get:

$F'(r) = d/dr\{[1–p(r)] * rL\} + d/dr\{p(r) * (C – L)\}$ (2)

After rearranging, we obtain:

$F'(r) = L[1–p(r)] + p(r)[(C – L) – rL]$ (3)

Setting $F'(r) = 0$, the optimal interest rate r* satisfies:

$L[1–p(r^*)] + p'(r^*)[(C – L) – r^*L] = 0$ (4)

When determining the loan interest rate, banks must not only consider the direct profit brought by the interest rate (the part of $L[1–p(r^*)]$) but also weigh the changes in the probability of default caused by the interest rate changes (the part of $p'(r^*)$) and the losses in the event of default (C – L). Therefore, banks should find a balance in practice, such that the additional profit brought by increasing the interest rate exactly offsets the marginal cost increased by high-risk defaults.

(2) Farmer Risk and Profit Analysis

In the rural inclusive finance system, farmers, as loan applicants, have their expected profits directly affecting their willingness to borrow and financing behavior. Given the high uncertainty in rural production and operations, the project returns for farmers using loan funds for agricultural production

or entrepreneurial activities can fluctuate significantly. To describe the profit status of farmers under loan conditions, this paper constructs a mathematical model based on the limited liability assumption.

Assume that the farmer obtains a loan amount of L at an interest rate of r, and thus the total repayment amount is (1 + r)L. The farmer invests the loan into a project, with the project returns denoted as the random variable X, having a probability density function f(x) and a cumulative distribution function F(x). Under the limited liability framework, the net profit of the farmer, π_f, can be expressed as:

$$\pi f = \begin{cases} X-(1+r)L, & \text{if } X \geq (1+r)L \\ 0 & \text{if } X < (1+r)L \end{cases}$$

The above equation indicates that if the project returns X meet the repayment requirements, the farmer obtains the residual profit X - (1 + r)L. Otherwise, due to limited liability protection, the farmer does not bear losses exceeding their asset capacity, and the profit is recorded as 0 (assuming no other punitive mechanisms are in place).

Therefore, the expected profit of the farmer, E(πf), can be generally expressed as:

$$E(\pi f)=\int_{\infty(1+r)L}[X-(1+r)L]f(x)dx$$

Only when the project returns exceed the repayment amount (1 + r)L can the farmer obtain positive profits, with the excess creating actual profit.

As the interest rate r increases, the repayment amount (1 + r)L also rises, meaning it becomes more difficult for the farmer to achieve positive profits. To quantify the impact specifically, consider the derivative of E(π_f) with respect to r:

$$d\pi f/dr=d/dr\int_{\infty(1+r)L}[X-(1+r)L]f(x)dx \quad (1)$$

After rearranging, we get:

$$d\pi f/dr=\int_{\infty(1+r)L}(-L)f(x)dx=-L.\{1-F[(1+r)L)]\} \quad (2)$$

The above result shows that an increase in the loan interest rate r will decrease the probability of the farmer obtaining positive profits [1 - F[(1 + r)L]], thereby reducing the expected profit, i.e., dπ_f/dr = -L[1 - F[(1 + r)L]] < 0.

(3) Guarantee Institution Risk and Profit Analysis

In the rural inclusive finance system, guarantee institutions play an important role in alleviating credit rationing problems. Due to the information asymmetry and high credit risks in farmer financing, banks often adopt strict approval standards for loans, making it difficult for some high-quality farmers to obtain credit support due to the lack of sufficient guarantees. Guarantee institutions provide credit endorsements for farmers to reduce bank risks and thus promote credit supply. However, guarantee institutions themselves also face risks, and they must bear certain compensation responsibilities when farmers default. Based on this, this paper uses the theory of credit rationing to construct an expected profit model for guarantee institutions to reveal their roles and incentive mechanisms in supply-side reforms.

Assume that the loan amount is L, and the guarantee institution charges a certain proportion of the loan

as the guarantee fee rate f, i.e., the guarantee fee is fL. When the farmer does not default, the guarantee institution only receives this guarantee fee. If the farmer defaults, the guarantee institution must pay a compensation amount gL (where g is the compensation ratio, $0 < g \leq 1$) in addition to the guarantee fee, as stipulated in the contract. Let the probability of the farmer defaulting be p, then the profit situation of the guarantee institution can be divided into two scenarios: First, when the farmer repays on time (with probability 1 - p), the guarantee institution receives a profit of fL. Second, when the farmer defaults (with probability p), the net profit of the guarantee institution is the guarantee fee minus the compensation loss, fL -gL.

Therefore, the expected profit of the guarantee institution, E(π_guar), can be expressed as:

$$E(\pi guar)=(1-p)fL+p(fL-gL) \quad (1)$$

After rearranging, we get:

$$E(\pi guar)=fL-p.gL. \quad (2)$$

This expression shows that the expected profit of the guarantee institution mainly depends on the guarantee fee income and the expected compensation cost brought by the default risk. To ensure that the guarantee institution has an economic incentive to participate in rural credit guarantee business, its expected profit must be positive, i.e., it should satisfy $fL > p.gL$, or $f > pg$. This inequality provides a theoretical basis for the guarantee institution to set the guarantee fee rate. In a high default-risk environment, it is necessary to increase the guarantee fee rate to compensate for possible compensation losses. Conversely, when the default risk is low, the guarantee institution can appropriately reduce the guarantee fee rate to further promote farmers' access to credit support and alleviate credit rationing problems.

3. Research Conclusions

This study, based on the theory of credit rationing, constructs expected profit models for banks, farmers, and guarantee institutions and explores the causes of supply constraints in rural inclusive finance. Information asymmetry, high difficulty in credit risk management, and an imperfect guarantee mechanism are the main reasons for the constraints on the supply of rural inclusive finance. Banks, concerned about default risks, often adopt strict credit approval and high interest rates, thereby suppressing some farmers' financing needs. Farmers' expected profits are affected by loan interest rates, fluctuations in agricultural project returns, and an imperfect credit rating system, leading to higher financing costs and thus reducing their willingness to borrow. Although guarantee institutions can alleviate credit rationing to some extent, their supply capacity is still constrained due to an imperfect guarantee mechanism and limited compensation ability for defaults. In response to the supply constraints in the rural credit market, this study proposes four key optimization paths, including improving the rural credit system, optimizing credit risk management, perfecting the guarantee mechanism, and reasonably setting loan interest rate levels. It emphasizes the need for coordinated efforts among the government, financial institutions, guarantee institutions, and borrowers to promote

the improvement and development of the rural financial system through institutional innovation.

3.1 Improving the Rural Credit System: Utilizing Big Data and Financial Technology to Enhance Credit Assessment Accuracy

The underdevelopment of the rural credit system makes it difficult for financial institutions to accurately assess the credit risks of farmers and small and micro enterprises, thereby affecting the accessibility of credit supply. To alleviate this issue, a variety of measures should be taken to improve the rural credit system and enhance the accuracy of credit assessments by financial institutions. Firstly, strengthening the integration and sharing of credit information is crucial. The government and financial institutions can jointly establish a nationwide rural credit database that consolidates information such as farmers' loan records, operating income, and land use rights, increasing the transparency and accessibility of credit data. The "Internet Plus" model can be adopted to leverage agricultural IoT and smart devices to collect real-time data on agricultural production and transactions, forming dynamic credit profiles to reduce information asymmetry. Secondly, utilizing financial technology to enhance credit assessment accuracy is essential. Big data analytics, artificial intelligence (AI), and machine learning have broad applications in rural credit assessments. By constructing credit scoring models based on farmers' daily transaction records, social network activities, and agricultural production data, a more precise evaluation of farmers' repayment capabilities can be achieved. For example, Ant Financial's "Sesame Credit" has already been promoted in some rural areas, providing more convenient loan approval services for small and micro farmers. Furthermore, enhancing credit culture construction and improving farmers' credit awareness is important. The government can guide policies to promote the popularization of credit rating systems and encourage farmers to actively maintain good credit records. Financial institutions can also offer incentives by providing lower interest rates or higher loan amounts to borrowers with good credit, encouraging farmers to adhere to financial contracts and increasing credit awareness, thereby reducing credit rationing caused by credit risks for banks.

3.2 Optimizing Credit Risk Management: Reducing Banks' Default Risks and Enhancing Credit Supply Levels

The high default risk in the rural financial market is a key factor affecting banks' credit supply. Given that farmers' income levels are relatively low and agricultural production is significantly affected by weather and market price fluctuations, banks often adopt conservative credit policies. Therefore, optimizing credit risk management and enhancing banks' credit supply capabilities are crucial for the development of rural inclusive finance. Firstly, building an intelligent risk assessment and monitoring system is necessary. Traditional credit risk assessment methods mainly rely on financial statements and collateral assessments, which are often difficult to obtain in rural areas. By using artificial intelligence and big data technologies, a more accurate credit risk assessment system can be constructed. For example, satellite remote sensing data can be used to monitor crop growth and combined with historical market data to predict future agricultural product prices, thereby assessing farmers' debt repayment capabilities. Secondly, advancing credit product innovation to diversify bank risks is important.

Currently, most banks offer relatively homogeneous rural loan products and lack flexible loan programmes tailored to the needs of farmers. Secondly, advancing credit product innovation to diversify bank risks is important. The development of ‘order-based agricultural loans’ based on the agricultural production cycle, in which banks cooperate with enterprises that purchase agricultural products and issue loans based on farmers‘ order contracts, can reduce banks’ credit risks. In addition, we have also promoted products that combine agricultural insurance with credit, such as the ‘weather index insurance + loan’ model, which can effectively reduce the risk of default due to natural disasters and increase banks' willingness to provide credit. Finally, strengthen policy support and build a reasonable risk compensation mechanism. The government can set up a rural credit risk compensation fund to partially compensate financial institutions for losses arising from rural loans, so as to increase the enthusiasm of banks to participate in rural finance. At the same time, the Government can provide low-interest loans to eligible farmers and small and microenterprises through an interest-subsidy policy to reduce financing costs, thereby expanding the supply of rural credit.

3.3 Improving the Guarantee Mechanism to Enhance the Sustainability of Guarantee Institutions

In the rural credit market, the lack of effective collateral from farmers makes banks cautious in approving loans, and the imperfect guarantee mechanism further exacerbates the shortage of credit supply. Therefore, improving the guarantee system is an important means to alleviate the constraints on rural financial supply.

Firstly, perfecting the policy-based guarantee system led by the government is crucial. The government can establish a rural credit guarantee fund to provide credit enhancement services for farmers and small and micro enterprises. For example, the China Agriculture Development Bank has already implemented a government-led agricultural credit guarantee system in some areas, improving the loan accessibility for farmers through government funding support. In addition, the government can also provide financial subsidies to qualified rural loan guarantee institutions to reduce their operating costs and enhance their sustainable operation capabilities. Secondly, developing market-oriented guarantee institutions and promoting diversified guarantee models is essential. In addition to the government-led guarantee system, market-oriented guarantee institutions should also be encouraged to develop. For example, agricultural cooperatives and rural commercial banks can act as third-party guarantors to improve farmers' loan accessibility. Moreover, mutual guarantee models, such as those between farmers or between agricultural enterprises and farmers, can be promoted. These models can reduce individual default risks through group credit, thereby increasing banks' willingness to lend. Finally, enhancing the risk management capabilities of the guarantee mechanism is important. Guarantee institutions should establish dynamic risk monitoring systems to track the operating conditions of guaranteed farmers in real-time and take risk control measures promptly to reduce overall guarantee risks. The government can also provide re-guarantee services for guarantee institutions to enhance their risk resistance capabilities and improve the sustainability of the guarantee system.

3.4 Reasonably Setting Loan Interest Rates to Avoid Adverse Selection Caused by High Interest Rates

The rational setting of loan interest rates has an important impact on the supply of rural finance. If the loan interest rate is too high, high-credit farmers may exit the market, while low-credit farmers, due to their urgent financing needs, will still choose to borrow. This leads to an increase in the proportion of high-risk borrowers in the credit market, further exacerbating the credit rationing problem for banks. Firstly, implementing differentiated interest rate pricing strategies is crucial. Banks can set different loan interest rates based on factors such as farmers' credit ratings, operating conditions, and loan purposes to reduce the financing costs of low-risk farmers. For example, farmers with higher credit ratings can obtain lower interest rates, while those with higher risks will need to pay higher interest rates. Risk mitigation measures, such as agricultural insurance, should also be provided to reduce potential losses. Secondly, the government can reduce farmers' financing costs through interest rate subsidies. The government can provide a certain proportion of interest subsidies for agricultural production-related loans, reducing farmers' financing costs and improving their credit accessibility. For example, in some countries, the government provides "zero-interest" or "low-interest agricultural loans" for small farmers, effectively promoting the development of agricultural production. Finally, promoting the development of inclusive finance and reducing banks' operating costs is essential. By promoting digital financial services, banks can reduce their operational costs in rural areas. Banks can maintain reasonable profits while lowering loan interest rates, thereby promoting the healthy development of the rural financial market.

4. Discussion

The conclusions of this study are consistent with domestic and international research findings. First, consistent with the credit rationing theory proposed by Stiglitz and Weiss (1981), the study finds that due to information asymmetry, banks tend to screen borrowers by increasing loan interest rates. However, higher interest rates attract high-risk farmers, increasing the probability of default and thereby exacerbating credit rationing problems. Second, in line with Bester's (1985) research, this study finds that banks can distinguish borrowers' credit risks by requiring different levels of collateral. However, the limited collateral available to rural farmers restricts the applicability of collateral-based lending models in rural inclusive finance. This finding is also consistent with Williamson's (1986) research on monitoring costs, which shows that high monitoring costs in rural financial markets further intensify credit supply constraints. Additionally, consistent with domestic research conclusions, Li and Wang (2023) found that the improvement of government and market-based guarantee systems helps reduce credit risks for rural financial institutions and enhances loan accessibility. The mathematical models in this study also demonstrate that guarantee institutions' profits are easily affected in high-default-risk environments. Therefore, setting guarantee fees and default compensation ratios reasonably is crucial for enhancing the sustainable operation of guarantee institutions. Lastly, Liu et al. (2022) showed that the development of digital inclusive finance can improve the efficiency of capital

allocation in rural credit markets, but this effect depends on the soundness of the credit evaluation system and the completeness of data infrastructure. This study similarly emphasizes the important role of financial technology in alleviating credit rationing and suggests optimizing credit rating systems through big data to enhance farmers' credit accessibility and improve the supply of rural finance.

In summary, the conclusions of this study are theoretically consistent with existing literature and further quantify the impact of various factors on rural credit supply through mathematical modeling. This research not only expands the application of credit rationing theory in the field of rural inclusive finance but also provides empirical evidence for future policy-making. Future research could combine larger-scale empirical data to explore the differences in rural financial supply constraints across regions and offer more precise policy recommendations.

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