Research on Financing Game Model of Small and Medium-sized Enterprises Based on Different Risk Categories

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Abstract

With the development of market economy and the deepening of economic system reform, some of the Small and medium-sized (SME) enterprises have become the most dynamic economic growth point in the national economy. Nevertheless, SMEs are facing a lot of problems in the market competition, such as technical backwardness, information lag, lack of talents, etc.. The healthy development of SMEs is very important, whereas, SMEs' financing is a worldwide problem, and the result of financing game between banks and enterprises depends on a variety of decision-making factors. In this paper, from the point of view of bank, we analyze the difficulties of external financing of SMEs, and establish a financing game model based on different risk categories, in order to better solve the problems that remain in the process of financing and promote the healthy and sustainable development of SMEs.

Keywords: Financing Game Model, Small and Medium-sized Enterprises, Risk Categories, Risk Management

Introduction

Whether in developed countries or in developing countries, the development of SMEs are the inherent requirements of the national economic prosperity, in order to better solve the problem of market economy, we have to figure out the financing problems of SMEs. SME's financing is a worldwide problem, which is called "Macmillan Gap" by international economists. The financing problem is sort of the possibility that funds are not implemented and financing costs are too large.

Jaffee (1969) suggested that the bank's credit supply curve is determined by the standard profit maximization principle, and Myers (1984) proposed that full information exchange is the key to corporate financing. The development of SMEs need funds to continue investing, and financing can be sorted according to the pecking order theory: internal financing, debt financing, and equity financing. In 1997, Martinelli put forward that the formation and gradual evolution of credit mechanism is very important for the distinction of different risk lending objects in credit market, and he emphasized the influence of the adverse selection in the credit market. Because the credit history of SMEs is relatively short, these SMEs have to face the constraints of bank credit. Gregory and Tanev had research on private enterprise financing problems in 2001, they figured out that bank's incentive policies, procedures, mortgage guarantee conditions, information problems are the main factor affecting the financing of SMEs. They provided several policy measures:

- Strengthen the encouraging measures of debit and credit sides.

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• Promote the process of liberalization of interest rates.
• Allow banks to charge transaction fees.
• Develop more lending practices.
• Promote the development of private property rights.

On the basis of fully understanding the financing risks faced by SMEs, the government needs to take all kinds of scientific and effective methods to prevent and control the risk of financing, by ensuring the continuity and stability of enterprise capital movement with the minimum financing cost. In this paper, we use game theory to study the financing of SMEs, which helps us to understand the interests of stakeholders in the case of asymmetric information strategy. According to the information we take the appropriate financing action, and can help to solve the problem of financing of SME.

The Proposed Methodology

Game Theory Model. By using the methods of game theory to solve the problem of financing between banks and SMEs provides us an effective way to solve the problem of cooperation between the two sides. In this paper, we introduce the basic game theory model to gradually explore the cooperative problem between banks and enterprises in financing.

• Participants: There are two participants in game model, bank \((B)\) and enterprise \((E)\), and both of them have their rational decision-making in order to maximize their own interests under a given situation. Due to asymmetric information, SMEs often hide their own adverse information, and only provide favorable information in order to raise funds, thus adverse selection is generated.
• Strategies: There are two strategies for SME: keeping promises or breaking promises; and there are two strategies for bank as well: acceptance or rejection, by the way there is no form of collusion or collusion between the parties.
• Information: In the game, the information of both sides is asymmetric, while the SMEs keep complete information. There are two types during natural selection process: keeping promises \((E_T)\) or breaking promises \((E_F)\). SMEs know what type they belong to, but the bank does not know, which can only judge the probability of SME, denoted as \(P\), and probability of breaking a promise is \((1-P)\).
• Payment: We assume that bank loans is the only financing channels for SMEs, and the cost of SME is sort of financing cost. For credit SMEs who put forward the loan application, if accepted, the average income of each item of SME is \(R(R>0)\), the profit is \(R-Mr\) \((M\) represents loan amount, and \(r\) is bank interest rate), and bank's profit is \(Mr\); if rejected, SME's profit is \(R+M(1+r)\), bank's profit is \(-M(1+r)\).

| Table 1. Game Payment Matrix of SME and Bank. |
|---|---|---|---|
| | Bank | Loan Accepted | Rejected |
| SME | Trustworthy | \((R-Mr, Mr)\) | \((-R-Mr), -Mr)\) |
| | Dishonest | \((R+M(1+r), -M(1+r))\) | \((0,0)\) |
**Model Establishment**

1. An Incomplete Information Static Game Model

In an incomplete information static game model, SMEs and banks do not share common knowledge. The type of SME is naturally selected and banks only understand the probability distribution of promise-keeping and promise-breaking.

SMEs’ business activities are not all successful after obtaining loan, thus, banks should take project success probability into account, and compare the expected return to determine whether the loan should be provided. We assume the probability of success of an enterprise is $P$, and probability of failure is $(1-P)$, thus, the expected return of the bank is

$$E(B) = PMr + (1 - P)[-M(1 + r)] = PM(2r + 1) - M(1 + r)$$

(1)

The expected return of SME is:

$$E(E) = P(R - Mr) + (1 - P)[R + M(r + r)] = R + M(1 + r) - MP(2r + 1)$$

(2)

Through (1), there is a critical value $P^*_1 = \frac{1}{2}(1 + \frac{1}{2r + 1})$, and if $P > P^*_1$, the loan is provided.

Similarly, $P^*_2 = \frac{R + M(1 + r)}{M(2r + 1)}$, and if $P < P^*_2$, the SME is trustworthy.

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Nature

<table>
<thead>
<tr>
<th>SME Type</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trustworthy SME</td>
<td>$P$</td>
</tr>
<tr>
<td>Dishonest SME</td>
<td>$1 - P$</td>
</tr>
</tbody>
</table>

**Figure 1. The Game Tree of An Incomplete Information Static Game Model.**

2. An Incomplete Information Dynamic Game Model

We assume there are two types of enterprises with good or bad business conditions applying for loans. A prior probability of good operating condition of the enterprise is $P$, and prior probability of bad operating condition of the enterprise is $(1-P)$; if SMEs with good operating condition apply for loan, the probability of bank lending is $s$; if SMEs with bad operating condition apply for loan, the probability of bank lending is $t$. Therefore, probability of provided bank loans is:

$$\tilde{P} = Ps + (1 - P)t$$

According to Bias rule, posterior probability of SME with good operating condition is:
\[ P(g) = \frac{P_s}{P_s + (1 - P)t} \]

and posterior probability of SME with bad operating condition is:
\[ P(b) = \frac{(1 - P)t}{P_s + (1 - P)t} \]

In conclusion, if \( P > \frac{t}{s + t} \), the banks think that SMEs have good operating condition.

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3. Risk Averse Game Model

As two sides of the game, SMEs and banks always maximize their profit from the average value, in fact, they all ignore the strategies adopted by other risk type enterprises. In this section, we apply Mean-Variance analysis to analyze the game model.

We assume that SME can obtain bank loans for \( \tilde{R} = R_0 + \varepsilon \), \( \varepsilon \in N(0, \sigma) \). \( k \) represents risk preference of SME, and if \( k = 0 \), SME is risk-neutral, if \( k < 0 \), SME is risk-averse.

If the bank accept the loans application, the expected utility of SME is:
\[
U(\tilde{R}, P, r, k) = E(E) - k \sqrt{Var(E)} = \tilde{R} + M(1 + r) - MP(2r + 1) - k\sigma
\]

In order to maximum the expected utility, we have:
\[
P < \frac{\tilde{R} + M(1 + r) - k\sigma}{M(2r + 1)}
\]

We can figure out that: \( \frac{\partial P}{\partial k} < 0 \), namely, with increasing of \( k \), the probability of keeping promise of SME will decrease.

4. Signaling Game Model.
In order to obtain the banks' trust, SMEs transmit signal(s) at first, including their operating conditions, credit rating, etc. When banks have these signals, they revise the prior probability according to Bias rule, and then obtain posterior probability. Thus we have:

\[ P(T) + P(F) = 1 \]

\[ \tilde{P} = \frac{P(X|T)P(T)}{P(X)} \]

If banks accept the loans application, expected return of SME is:

\[ E(E) = \tilde{P}(T|X)(R - Mr) + \tilde{P}(F|X)[R + M(1 + r)] \]

and the maximum benefit is:

\[ \max E(E) = \tilde{P}(T|X)(R - Mr) + \tilde{P}(F|X)[R + M(1 + r)] \]

**Conclusion**

In this paper, facing the financing risk of small and medium-sized enterprises based on different risk categories, we apply game theory into this issue. We introduce four different game models to analyze appropriate financing channels between banks and SMEs, and we suggest several proposal to solve the problems of information asymmetry among them.

- Establishing a credit system: The main reason for the SMEs to break faith strategy is the lack of credit system, thus an appropriate credit system need establishing immediately. Government should apply bankruptcy liquidation for those SMEs whose intention is to break the trust.
- Establishing incentive mechanism: Establish and improve all kinds of relevant policies, and banks can credit SMEs to relax lending policies. Through a good credit rating agency, banks can record the long-term repayment of SME, which is a conducive way.
- Establishing an information collection platform: Banks should make full use of modern media, such as Internet, in order to better understand more private information of SME and ensure the rationality of the decision.
- Improving the service system: Some facilitating agencies should guide SMEs to make reasonable strategic choice on financing, credit guarantee, management, investment planning, etc.

**References**


