Game Theory Analysis on Accounts Receivable Financing of Supply Chain Financing System

FANG LIU and LINGNA MO

ABSTRACT

Difficult finance is a common problem for many small and medium-sized enterprises, however, finance services of supply chain provide a new way to solve the problem. Based on the game theory, this article studied the decisions about accounts receivable financing by the supplier, the manufacturer and the bank. The research show that accounts receivable financing may be the effective way to solve the difficult finance of small and medium-sized enterprises. Enterprises will choose long-term cooperation in order to get the persistent profit.

KEYWORDS

Accounts receivable financing, game theory, Small and medium enterprises.

INTRODUCTION

According to the China SME Association SME financing survey, more than half of the enterprises surveyed have financing needs in the process of development and growth. However, the actual situation, there are still many small and medium enterprises because of poor credit records, lack of collateral and other reasons, it is difficult to obtain bank loans and other external financing, even if the financing also had to bear higher financing costs, and sometimes even beyond its affordability. In the survey, 23.5% of the enterprises that financing difficulties restricting its development.

Due to the limited size of small and medium-sized enterprises and the lack of asset guarantees and other reasons, it is difficult to obtain loan support from banks, supply chain financing came into being. In the global complex network formed by the supply chain, the dominant core enterprises are often strong multinational manufacturing enterprises, they usually use its dominant position to the upstream enterprises to postpone payment to the downstream enterprises Yah, so that the supply chain the network in a weak position of suppliers and distributors (usually small and medium enterprises) have a huge funding gap. In the supply chain financing, small and medium enterprises in the core business under the guarantee, apply for loans to the bank. Supply chain financing products are mainly divided into accounts receivable financing, logistics finance, procurement financing and other three models [1]. The pledge registration system of the People's Bank of China has provided a good platform for the financing of accounts receivable. Therefore, the pledge financing of accounts receivable has been developing rapidly in our country.

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FINANCIAL SYSTEM FRAMEWORK FOR FINANCING SUPPLY CHAIN BASED ON ACCOUNTS RECEivable

Accounts receivable financing refers to the enterprise in order to obtain operating funds, the seller and the buyer signed a real trade contract arising from the accounts receivable, to the seller to the contract under the accounts receivable as a source of repayment Financing business [2]. Consider a supply chain consisting of a supplier and a manufacturer. The manufacturer to a certain wholesale price to the supplier to buy a certain amount of a single raw material, and then create a product sold to the commodity market.

Assuming that the supplier does not receive the payable, its own funds are not sufficient for re-purchase. In the process of financing the supply chain receivables financing, the core enterprises play the role of counter-guarantee, once the financing companies can not repay the loan interest, the bank has the right to ask the core business loan losses [3]. The framework of the supply chain financial system based on accounts receivable is shown in Fig 1.

TRIPARTITE GAME MODEL UNDER THE MODE OF RECEIVABLE FINANCING

Small and medium-sized enterprise accounts receivable financing, in essence, is the small and medium enterprises, the core business and bank tripartite game. SME will weigh the pros and cons, in the cost of loans and bring the benefits of comparison, based on whether to determine whether to mortgage. There are also two options for repayment and non-repayment. Banks as lenders, in order to reduce the credit risk, determines whether the accounts receivable as collateral to small and medium enterprises to issue loans. The different choices of the three parties will produce different results, so the problem is analyzed by means of game theory.

Basic game hypothesis

(1) "Small business (supplier)" , "core enterprise (purchaser)" and "bank" involved in the financing of accounts receivable under the objective constraint to maximize the
efficiency of their own, are based on the pursuit of their own interests to maximize the risk of the lowest decision-making basis.

(2) In a game, the bank does not understand the full financial data of small and medium enterprises, credit information, etc., in the inferior position of information, are incomplete information game; but in many games, the bank gradually understand the credibility of small and medium enterprises, financial situation. Repayment ability and other information, and in the course of the game the three main body of the other subject of the strategic space and payment to understand, can be seen as a complete information game.

(3) Financing game for the non-cooperative game, that is, the interaction between the three parties there is no form of any conspiracy or string of the three parties only to maximize their own interests for the purpose.

(4) Three-party game for the dynamic game, that is, in the game is not the three parties at the same time action, but in the small and medium enterprises with core business accounts receivable as collateral to the bank after the loan application, the bank first to choose whether the loan to the game, Small and medium enterprises and the core business around whether the issue of repayment of the camera action, so the game is a dynamic game of order [4].

The payment of the game

If the bank chooses not to lend money, the supply chain financial accounts receivable financing can not be realized, the three parties' income is 0. When the bank provides the loan, the manufacturer has two options: the contract (the payment and the supplier defaults to pay the interest), breach of contract (no repayment does not pay interest), the supplier also has two options: compliance (payment of interest, when the manufacturer does not repay the loan), breach of contract (no payment of interest, no repayment). Because it is a dynamic game, so the tripartite action has the order, the bank first choose whether to loan the supplier, and then the manufacturer chooses whether to repay, when the manufacturer defaults, the supplier decides whether to repay the loan to the bank.

When the manufacturer is in compliance, the bank defaults the bank to recover the principal and interest, the manufacturer pays interest to the supplier, and loses the benefits of the supply chain. The supplier loses the supply chain gains S, The credit drop will have other losses assumed to be F. When the supplier is in compliance with the manufacturer's default, the bank has the right to recover the principal from the supplier and obtain interest income, the manufacturer's default will be punished by the supply chain financing system and lose the supply chain gains S; accounts and lose supply chain revenue. When both are in default, the bank can not recover the principal and interest, the manufacturer default will be punished T, and the supply chain gains will be lost S; the supplier loses the supply chain gains and losses.

When both are in compliance, the bank can recover the principal and interest, both sides can get the supply chain earnings.
### TABLE 1. THE PAY OFF MATRIX.

<table>
<thead>
<tr>
<th>Bank loan</th>
<th>supplier</th>
<th>Keep the contract $P_1$</th>
<th>Breach of contract $1 - P_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_1_I</td>
<td>R-I+S</td>
<td>R-F+I</td>
<td></td>
</tr>
<tr>
<td>P_2_C</td>
<td>I-C</td>
<td>I-C</td>
<td></td>
</tr>
<tr>
<td>1 _ P_2</td>
<td>W_n-M+S</td>
<td>W_n-M</td>
<td></td>
</tr>
<tr>
<td>1 _ P_2</td>
<td>R-I-M</td>
<td>R+I-F</td>
<td></td>
</tr>
<tr>
<td>1 _ P_2</td>
<td>I-C</td>
<td>-C-M</td>
<td></td>
</tr>
<tr>
<td>1 _ P_2</td>
<td>M-T</td>
<td>M-T</td>
<td></td>
</tr>
</tbody>
</table>

Assuming that the interest earned by the supplier from the bank financing and investment is R, the interest paid to the bank is I, the supplier finances from the bank to M (i.e., the balance between the supplier and the manufacturer, in order to simplify the fact that the receivables are no longer considered separately), the discount rate of banks to small and medium-sized enterprises is $\delta$, $0 < \delta < 1$. The cost of each of the manufacturers' transactions with the supplier is W Bank's costs for supervising the repayment of the firm from top to bottom for the supplier 1, the bank 2, and the producer 3 in turn.

### Analysis of a Game Process

According to the basic principles of the game, the ultimate goal of the parties to achieve the game is: under the influence of other parties, the pursuit of their own interests to maximize. Let $P_1$ be the probability of the repayment of the supplier, $P_2$ indicates the manufacturer and the repayment probability, $0 \leq P_2 \leq 1$, $0 \leq P_1 \leq 1$, $0 < C < I < W < R < M$, in a game $n=1$, $S=0$, $F=0$, $T=0$, the three expected returns are as follows:

**Manufacturer's expected return:**
- When observing: $E_1 = P_2 \times P_1 \times (W - M) + P_2 \times (1 - P_1) \times (W - M) = P_2 \times (W - M)$
- Breach of contract: $E_2 = (1 - P_2) \times M$
- Benefit from the supplier's business:
- When observing: $E_3 = P_1 \times P_2 \times (R - I) + P_1 \times (1 - P_2) \times (R - I - M)$
- Breach of contract: $E_4 = (1 - P_1) \times (R + I)$
- Bank's expected income:
- When lending: $E_5 = (P_1 + P_2 - P_1 \times P_2) \times (I - C) + (1 - P_2) \times (1 - P_1) \times (-C - M)$
- When not lending: $E_6 = 0$

From the above three expected earnings can be seen in a game process, because the supply chain business may be a breach of contract, the conservative bank will not choose to lend money at this time to 0, but the bank is the pursuit of profit if the bank that the probability of default business will take the risk of choice to lend. When the bank lends when the manufacturer defaults more than the proceeds from the contract, the supplier will choose to default; based on the manufacturer's default, it is clear that the supplier defaults more than the contract. So, in a game of the three concluded that: banks will be small and medium enterprises to finance receivables to obtain transactions, and small and medium enterprises and core companies will choose not to
pay for the proceeds, the final game results. The bank has a negative income, small and medium enterprises and the core business generated positive returns.

Analysis of multiple game processes

The above game analysis is based on a game. In a game, the parties to the game on each other's financial situation, the credibility of the situation are not very deep understanding, especially in the bank, if the company to determine whether the issue of loans on the issue of deviation, it is easy to lead to financing business opportunities. Behavior, and ultimately difficult to generate efficient game equilibrium. However, the bank will also take measures to avoid the recurrence of such incidents in the bank's business not only for small and medium enterprises to provide loans, as well as its opening of bank accounts to help them carry out daily cash receipts and payments, to provide international settlement Services and a variety of investment and financial management business, in the banking and SME business under the premise of complex, small and medium enterprises for the normal operation of enterprises generally do not because of a fixed amount of loans and give up the opportunity to continue cooperation with the bank.

Moreover, once the occurrence of default in small and medium enterprises, but also subject to legal sanctions, not only by bank litigation, but also in the credit market lost credit, with bad credit records, reducing the credit rating of the enterprise, resulting in other Banks and financial institutions have refused to cooperate with them, then it will be difficult to refinance. SME are also well aware of this truth, therefore, although the default can bring temporary benefits to the enterprise, but for the future long-term development, most companies will still choose to recover the core business repayment [5]

Small and medium enterprises and the core business between the game is the case, if the core business has a maturity can not repay the record on time, small and medium enterprises in the next sale will be taken when the sale or rejection, the long run, the core business purchase channels Become more and more narrow, demanding higher and higher, is not conducive to the normal production and operation of enterprises. In the actual situation, the banks, small and medium enterprises, the core business transactions there is a long-term cooperation, and therefore produced a number of games.

Manufacturer Expectations Revenue:  

\[ E_1 = P_2 \times (W \times (n - M + S)) + P_1 \times (1 - P_2) \times (W \times (n - F)) \]

Breach of contract  

\[ E_2 = (1 - P_2) \times (M - T) \]

With the n close to infinity, the core business compliance brought about by the infinite income, so the core business if you want to get this long-term income, then you must choose to pay the payment before the expiration date. So, for the ultimate long-term interests, the core business will choose to keep the contract; if the penalty for the manufacturer's default is too large, then the default is likely to be 0, so the firm assumes that the firm will not choose to default.

Supplier expected return:

When observing:  

\[ E_3 = P_2 \times (R - I + S) + P_1 \times (1 - P_2) \times (R - I - M) \times (1 + \delta + \delta^2 + \delta^3 + ......) \]

Breach of contract  

\[ E_4 = (1 - P_1) \times (R + I - F) \]
When \( n \) tends to infinity, \( \delta \) n tends to infinity, the proceeds of the supplier’s compliance

\[
E_5 = P_1 \times P_2 \times (R - I + S) + \frac{P_1 \times (1 - P_2) \times (R - I - M)}{1 - \delta}
\]

When \( E_5 > E_4 \)

Suppliers will repay, \( P_1 > \frac{(1 - \delta)(R + I - F)}{(1 - P_2)(R - I - M)} \)

When the F greater the cost of default, the smaller the value on the right side of the equation, \( P_1 \) is greater than the smaller the value, So the greater the likelihood of compliance. If \( \delta \) greater, the smaller the value on the right side of the equation, the smaller the value \( P_1 \) is greater than, so the greater the likelihood of repayment, that is, the greater the discount rate, the greater the likelihood of repayment. If M greater, the greater the value on the right side of the equation, the greater the value \( P_1 \) is greater than, so the less the possibility of repayment, that is, the greater the amount of money, the smaller the possibility of reimbursement of SME.

Bank’s expected income:

When lending:

\[
E_4 = (P_1 + P_2 - P_1 \times P_2) \times (I - C) + (1 - P_2) \times (1 - P_1) \times (-C - M) \times (1 + \delta + \delta^2 + \delta^3 + \ldots)
\]

When not lending: \( E_6 = 0 \)

When \( n \) tends to infinity, if the bank lend \( E_5 > E_6 \) so:

\[
(P_1 + P_2 - P_1 \times P_2) \times (I - C) + (1 - P_2) \times (1 - P_1) \times (-C - M) > 0
\]

\[
(P_1 + P_2 - P_1 \times P_2) \times (C - I) < (1 - P_1) \times (1 - P_2) \times (C + M)
\]

apparently established, so based on the economic man, the bank will provide a loan.

Repeatedly repeated by the above game shows that if the transaction is continuous, even if there is no external constraints, the parties to the transaction for the long-term interests and the formation of an effective game balance. This is because the dishonesty will be punished, and cooperation will be the proceeds, which makes repeated game can inhibit the short-term behavior of enterprises, the possibility of punishment to ensure the efficiency of each game to promote the tripartite long-term stable cooperation, Repeat the game to bring the "efficient" place.

**SUMMARY**

This paper puts forward some policy suggestions from the perspective of government departments, commercial banks and small and medium-sized enterprises, and hopes to provide some reference and help for the financing of accounts receivable of small and medium-sized enterprises.

Government sector perspective. Therefore, this paper argues that the government should improve the relevant legal environment of financing, establish and improve the relevant laws and regulations, standardize the accounts receivable financing system, especially in the case of illegal dishonesty, because large-scale enterprises use their own advantages to small and medium enterprises accounts receivable often To extend the payment method, the production and operation of small and medium enterprises has brought great inconvenience, therefore, should increase the large-scale enterprises to punish the efforts of the follow-up of the business process and the relevant departments of the powers and responsibilities of a clear, For the game to establish a good environment to ensure the smooth progress of accounts receivable financing. At
the same time on the supply chain system to increase the penalties for breach of contract, you can open its breach of contract or increase the fine of default.

Commercial bank perspective. Commercial banks in the financing business on the one hand is the supply of funds, on the other hand is the pledgee, in the core of the entire business. Therefore, although through a number of game methods can understand the credit level of SMEs, restricting corporate irregularities, but this way time and labor. In order to facilitate the bank to quickly identify the risk level of accounts receivable financing enterprises, banks should establish a credit management information platform for small and medium-sized enterprises, establish a scientific credit rating system, and use their own information collection on the advantages of through various channels.

Small and medium enterprises perspective. Small and medium-sized enterprises as the biggest beneficiaries of the financing process, should seize the financing of accounts receivable as its opportunity to solve the problem of financing, through the continuous improvement of their own management to enhance the quality of corporate reputation, so the first time to the bank When the mortgage is financed, it will meet the conditions. Therefore, in order to enhance their own credit, enterprises should enhance the sense of integrity, external accounts to implement strict schedule repayment system, establish a trustworthy corporate image. At the same time in the enterprise to establish a standardized financial system and the credit system, do a risk prevention and management, and credit on the purchase side of the credit and financial aspects of a comprehensive judgment to eliminate blind sales behavior to improve accounts receivable In order to ensure long-term friendly relations with banks and core enterprises.

REFERENCES