A Research on the Pricing of Receivables Financing for Small and Medium-sized Logistics Enterprises Based on Supply Chain Finance

Aimin Deng, Rong Chen

Abstract—The receivables arose after small and medium-sized logistics enterprises supplied manufacturer with services, which influenced the operations of the logistics enterprises. In order to alleviate the capital pressure of small and medium-sized logistics enterprises and promote the sustained and good development of supply chain, in this paper, we take the financing advantage of supply chain finance and design the model of receivables financing of small and medium-sized logistics enterprises based on the supply chain finance theories, using the Stackelberg model and inferring the optimal pricing and the optimal profit of the bank and the Small and medium-sized logistics enterprises, And carry out data simulation. All these can provide the small and medium-sized logistics enterprises with a cost-effective financing program.

Index Terms—Supply chain finance, Small and medium-sized logistics enterprises, Receivables financing, Pricing game

I. INTRODUCTION

The logistics industry has developed rapidly as a tertiary industry. The total social logistics of china in 2015 is expected to reach 220 trillion yuan, up about 70% over 2010. According to the China Federation of Logistics and Purchasing assessment, small and medium logistics enterprises in the logistics industry accounted for up to 99%. Actually small and medium-sized logistics enterprises in the course of operation due to working capital, accounts receivable payment days, equipment funds to bear the huge financial pressure. But by its own economic benefits, less available for mortgage assets, small size and other factors, the financing is difficult. Yong-qiang Shi[1] (2012) shows that a major factor hindering the development of small and medium-sized logistics enterprises is the lack of funds and the high proportion of accounts receivable.

II. LITERATURE REVIEW

The application of supply chain finance makes the financing of small and medium-sized logistics enterprises from the traditional bank credit service to the use of the entire supply chain credit and funds as a support for financing. Domestic and foreign scholars launched an in-depth study on the supply chain finance. Michael L[2] (2008) concluded the definition of supply chain finance by summing up the

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previous studies and argues that supply chain finance is a process of system optimization of the availability and cost of funds in a core-dominated system. Subsequent application of the literature on supply chain financial and quantitative analysis to determine the value of the supply chain finance[3]-[7]. For accounts receivable financing of supply chain finance, Xiong Shao yu [8] (2009) applying e-commerce to supply chain finance discovery that it can form a closed-loop financing system to ensure the self-sufficiency of the transaction and put forward the process of accounts receivable financing to propose the process of accounts receivable financing. Demica [9] (2009) study shows that 61% of UK companies and 43% of German companies are planning to rely on accounts receivable (Including reverse factoring, seller financing, supplier financing) for financing. As well as a series of studies on the mode of financing, processes and significance of accounts receivable [10]-[12]. Domestic scholars have done research of the pattern of supply chain finance accounts receivable financing, risk analysis and assessment, advantage analysis[13]-[16]. For pricing research, Sun Xi-mei[17] (2014) constructs the Stackelberg game model of suppliers, core firms and banks, introduce the bank's loan value ratio and find the optimal ratio, get the best output and order quantity for suppliers and core companies, and uses an example to validate the decision optimization model.

Domestic and foreign scholars have done extensively research on the small and medium-sized logistics enterprises, supply chain finance and accounts receivable financing, but there are some shortcomings. Rare scholars combine the reality of China from the angle of supply chain to solve the fund shortage of small and medium-sized logistics enterprises and the problem of high accounts receivable. This paper uses this as the breakthrough point to construct the financing model of the small and medium-sized logistics enterprises, and uses the Stackelberg game model to price the model.

III. THE FINANCING MODE OF ACCOUNTS RECEIVABLE IN SMALL AND MEDIUM-SIZED LOGISTICS ENTERPRISES

A. Operational Subject Analysis

In order to simplify the model, we assumed that the main operations are small and medium-sized logistics enterprises, manufacturers and banks. The receivables arose after small and medium-sized logistics enterprises supplied manufacturer with services, but manufacturers usually pay their bills at the end of the billing cycle. During the billing cycle, small and medium-sized logistics enterprises' cash flow problems which hinder the development of enterprise

may come up. The financing of accounts receivable can bring the funds back in advance and reduce the financial pressure of small and medium-sized logistics enterprises. Meanwhile, manufacturers can lengthen the settlement cycle, ease the financial pressure to promote the stability of the entire supply chain. Banks can further expand the SME financial services business and increase the bank's low-risk income. This model also has certain risk problems, the main risk is due to the fraud of small and medium-sized logistics enterprises and manufacturers, as well as the deterioration of the quality of accounts receivable or the reduction of the amount. As the first source of repayment, the manufacturer's timely payment is an important guarantee for the recovery of the loan, and there may also be fictitious receivable accounts of financing companies.

B. Operation Process Analysis

Accounts receivable financing refers to give the undue receivables to the bank for financing. Taking into account the logistics business and manufacturers of business dealings, this paper mainly consider the accounts receivable pledge financing. The basic process shown in Figure 1.
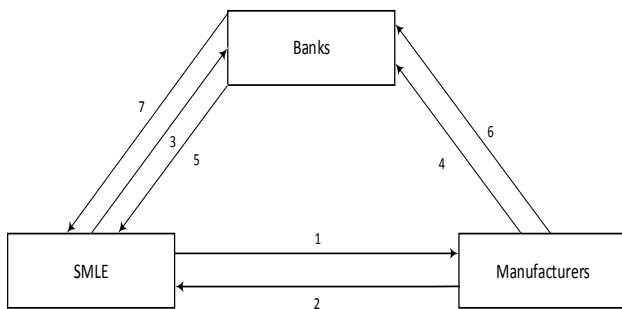

Figure 1. The model of receivables financing of small and medium-sized logistics enterprises (SMLE)

The main process: 1. small and medium-sized logistics enterprises provide manufacturers with logistics services. 2. Manufacturer's payback period is not yet, unable to pay, which forms accounts payable of small and medium-sized logistics enterprises accounts payable. 3. Small and medium-sized logistics enterprises will pledge receivables to the bank for financing, and pay a certain deposit. 4. The manufacturer issues proof of accounts payable to the bank and agrees to supervise the repayment of small and medium-sized logistics enterprises. 5. Bank loans to small and medium-sized logistics enterprises, and charge a certain loan costs. 6. The manufacturer repays the receivables to the bank on the maturity date of the financing. 7. Banks write off accounts receivable pledge contracts, and refund the deposit to small and medium logistics enterprises.

IV. MODEL ANALYSIS

A. Model Assumptions and Symbols Figures and Tables

This paper assumes that the receivables financing model participant is a rational "economic man". The three parties all with their own profit maximization as the goal. So there is a certain contradiction which leads to game behavior between them. Here mainly consider the small and medium-sized logistics enterprises in the process of financing with the bank's game behavior. The main consideration in the process of the financing is the game behavior of small and

medium-sized logistics enterprises and Banks. Assuming the bank is in a relatively strong position, small and medium-sized logistics enterprises in a relatively weak position, and pricing the accounts receivable financing model by the Stackelberg game model.

To facilitate the analysis, the following basic assumptions are constructed: 1. Manufacturers are the strength of the core business, and there will be 3-4 months settlement period which form the accounts receivable of small and medium-sized logistics enterprises after the logistics services provided. 2. Small and medium-sized logistics enterprises pledge receivables to the bank for financing, and pay a certain deposit. With the manufacturer's high credibility it can obtain loans lower than the traditional lending rate and if it default bank will deduct its margin.

On the basis of the assumptions, we make the following symbol definitions, p : the unit price of small and medium-sized logistics enterprises to provide manufacturers with logistics services, $p > 0$; $F(p)$: an exponential demand function, it means the demand for logistics services by manufacturers, Which is equivalent to small and medium logistics enterprises logistics services. $F(p) = mp^{-n}, m > 0, n > 1$, Where m represents the manufacturer's income and n is a constant, so the total amount of accounts receivable of small and medium-sized logistics enterprises is $pF(p)$; k : The proportion of the deposit of small and medium-sized logistics enterprises, $0 < k < 1$; δ : manufacturer default rate; r : the accounts receivable financing loan interest rates of Banks; C_l : the unit cost(management costs and business costs) caused by the purchase and sales relationship of small and medium-sized logistics enterprises and manufacturers; r_0 : the loan cost is the deposit interest rate; α : pledge rate;

π_l : financing income of small and medium-sized logistics enterprises, $\pi_l > 0$; π_b financing income of banks, $\pi_b > 0$.

B. Subjective Revenue Model

In this model, The bank's action portfolio is (loan, not loan), Small and medium-sized logistics enterprises' action portfolio is (financing, not financing), Manufacturer's action portfolio is (default, not default), The order of the game: 1. The bank determines the interest rate; 2. Small and medium-sized logistics enterprises determine the service price p. Then you can build a tripartite game tree as shown in Figure 2.
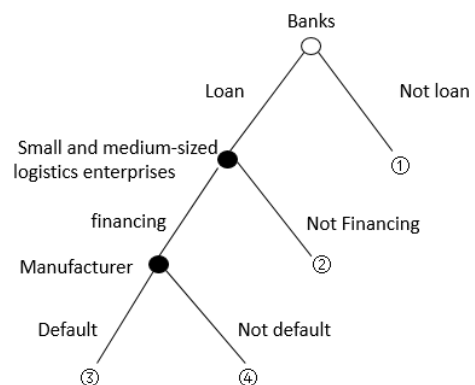

Figure 2 Bank, small and medium-sized logistics enterprises and manufacturers' game tree

And in this Stackelberg model, the actual participation in the game only the bank (leader) and small and medium logistics enterprises (followers). Then, financing income of Small and medium-sized logistics enterprises= Financing income- cost, According to the assumption that the total amount of accounts receivable is $pF(p)$, If the manufacturer does not breach the contract, Financing income of small and medium - sized logistics enterprises is $pF(p)\alpha$, The cost is the sum of the pledged portion of the financing of small and medium-sized logistics enterprises, the interest on financing loans and the total cost of providing the logistics service $pF(p)\alpha r+(1-\alpha)pF(p)+C_lF(p)$. If the manufacturer defaults, you will need to deduct the deposit $kpF(p)$. Similar to the bank's financing benefits. If the manufacturer does not default, the proceeds are the loan proceeds minus the cost of loan $(r-r_0)\alpha pF(p)$. If the manufacturer defaults, if the manufacturer defaults, the proceeds are the deposit minus the loan amount and the deposit interest cost of the loan amount $kpF(p)-\alpha pF(p)(1+r_0)$. Then the payment function is:

① $(0, 0)$

② $(0, 0)$

③ $([(1-r)pF(p)\alpha-(1-\alpha)pF(p)-C_lF(p)](1+r_0)$,

$[(1-r)p\alpha-(1-\alpha)p-C_l-kp]F(p)$)

④ $((r-r_0)\alpha pF(p)$,

$[(1-r)p\alpha-(1-\alpha)p-C_l]F(p)$)

The expected return for small and medium-sized logistics enterprises is

$$\pi_l=\{p[(2-r)\alpha-1-\delta k]-C_l\}mp^{-n} \tag{1}$$

Known $\pi_l>0$, by (1) can be launched

$$p>\frac{C_l}{(2-r)\alpha-1-\delta k}$$

And $p>0$, $C_l>0$ then $(2-r)\alpha-1-\delta k>0$,so

$$r<\frac{2\alpha-\delta k-1}{\alpha} \tag{2}$$

The Bank expected income is

$$\pi_b=[(r-r_0)\alpha+\delta k-\delta\alpha(1+r)]mp^{1-n} \tag{3}$$

And $p^*>0$, $F(p)>0$, $\pi_b>0$ then $(r-r_0)\alpha+\delta k-\delta\alpha(1+r)>0$, then,

$$r>\frac{(r_0+\delta)\alpha-\delta k}{(1-\delta)\alpha} \tag{4}$$

Only when (2), (4) at the same time to meet, means:

$$\frac{(r_0+\delta)\alpha-\delta k}{(1-\delta)\alpha}<r<\frac{2\alpha-\delta k-1}{\alpha}$$

The income of small and medium-sized logistics enterprises and banks are greater than zero, the two sides will participate in the financing business.

C. Principal Benefit Analysis

This paper assumes that the bank is in a dominant position, small and medium-sized logistics enterprises at a disadvantage. After the bank determine the loan interest rate r, small and medium-sized logistics enterprises determine unit price p of providing logistics services for manufacturers. Pushed back by Stackelberg game, we should firstly determine the response function of small and

medium-sized logistics enterprises and find the optimal solution p^*

First order derivative the decision variable p based on (1):

$$\frac{d\pi_l}{dp}=[\alpha(2-r)-1-\delta k]mp^{-n}-\{p[\alpha(2-r)-1-\delta k]-C_l\}mnp^{-n-1}$$

Second order derivative the decision variable p

$$\frac{d^2\pi_l}{dp^2}=(n+1)mn\{p[\alpha(2-r)-1-\delta k]-C_l\}p^{-n-2} \tag{5}$$
$$-2[\alpha(2-r)-1-\delta k]mnp^{-n-1}$$

To make the financing of small and medium-sized logistics enterprises there is a maximum returns, will be expected to meet the needs of small and medium-sized logistics enterprises profit function is concave function and guarantee the benefits of the enterprise is greater than zero, then: $\frac{d^2\pi_l}{dp^2}<0$ and $\pi_l>0$,Substituting (1), (5) into them, simplified and available

$$\frac{C_l}{(2-r)\alpha-1-\delta k}<p<\frac{(n+1)C_l}{(n-1)[(2-r)\alpha-1-\delta k]}$$

When p satisfies the above formula, the financing income π_l of the small and medium-sized logistics enterprises has the maximum value. Then the first order derivative is equal to zero which can launch p^*

$$p^*=\frac{nC_l}{(n-1)[(2-r)\alpha-1-\delta k]}$$

From the above formula we can see that the optimal pricing p^* of the small and medium-sized logistics enterprises is proportional to the bank's loan interest rate r, the manufacturer's default rate δ, the proportion of the deposit of the logistics enterprise k. When r, δ and k are higher, the service price of small and medium-sized logistics enterprises is higher. Meanwhile, Its pricing is inversely proportional to the pledge rate α.

Substituting p^* into π_b.

$$\pi_b=m[(r-r_0)\alpha+\delta k-\delta(1+r)\alpha]\left(\frac{nC_l}{n-1}\right)^{1-n}[[(2-r)\alpha-1-\delta k]]^{n-1}$$

The first order of r is derived

$$\frac{d\pi_b}{dr}=m\left(\frac{nC_l}{n-1}\right)^{1-n}\{(1-\delta)\alpha[(2-r)\alpha-1-\delta k]^{n-1}+[(1-\delta)r\alpha-\alpha r_0+$$
$$(k-\alpha)\delta](n-1)(-\alpha)[(2-r)\alpha-1-\delta k]^{n-2}\}$$

The second order of r derived

$$\frac{d^2\pi_b}{dr^2}=m\left(\frac{nC_l}{n-1}\right)^{1-n}\{2(1-\delta)(1-n)\alpha^2[(2-r)\alpha-1-\delta k]^{n-2}+\alpha^2$$
$$(n-1)(n-2)[(1-\delta)r\alpha-\alpha r_0+(k-\alpha)\delta][(2-r)\alpha-1-\delta k]^{n-3}\} \tag{6}$$

To make the financing of banks there is a maximum returns, will be expected to meet the needs of banks' profit function is concave function and guarantee the benefits of banks is greater than zero, then: $\frac{d^2\pi_b}{dr^2}<0$ and $\pi_b>0$ .Substituting (3) 、 (6) into them, simplified and available:

$$\frac{(r_0+\delta)\alpha-\delta k}{(1-\delta)\alpha}<r<\frac{[2(1+\delta)-n]\delta k+[n-2)r_0+\delta(n-6)+4]\alpha-2}{(1-\delta)\alpha n}$$

When r satisfies the above formula, the financing income of banks has the maximum value. Then the first order derivative is equal to zero which can launch r^*

$$r^*=\frac{(1-\delta)[2\alpha-1-\delta k]+(n-1)[r_0\alpha-(k-\alpha)\delta]}{\alpha(1-\delta)n}$$

Substituting r^* into p^*

$$p^{**} = \left(\frac{n}{n-1}\right)^2 \frac{C_l}{(1-\delta)[2\alpha-1-\delta k]+r_0\alpha-(k-\alpha)\delta}$$

Then the optimal financing pricing of small and medium-sized logistics enterprises and bank is:

$$p^{**} = \left(\frac{n}{n-1}\right)^2 \frac{C_l}{(1-\delta)[2\alpha-1-\delta k]+r_0\alpha-(k-\alpha)\delta} \quad \text{and}$$

$$r^* = \frac{(1-\delta)[2\alpha-1-\delta k]+(n-1)[r_0\alpha-(k-\alpha)\delta]}{\alpha(1-\delta)n}$$

Substituting r^* and p^{**} into type (1) and (3), we can launch the maximum income of both sides Max $\pi_l(p^{**})$ and Max $\pi_b(r^*)$. When the small and medium-sized logistics enterprises and banks financing pricing are p^{**} and r^*, the two sides in the process of financing will achieve a win-win situation.

D. Analysis of Game Results

Under the assumption of small and medium-sized logistics enterprises are not default, the manufacturer's default rate determines the level of risk financing model. Low default rate arouses low investment risk, bank loans will be relatively lowing interest rates. As the optimal pricing and maximum revenue expression is complex, it is difficult to carry out mathematical analysis, then the numerical simulation research method is used. The effect of δ on r^*, π_b and π_l when the other parameters take a certain value ($n=15$, $k=0.3$, $m=1$, $\alpha=0.7$, $r_0=0.0035$, $C_l=0.1$) can be shown in the following figures.

As can be seen from Figure 3, with the rise in the manufacturer's default rate, the bank loan interest rate is gradually rising. The reason is that the breach of contract of manufacturer is the main source of financing risk, the increase in default rate to force banks to raise interest rates to offset their own risk.
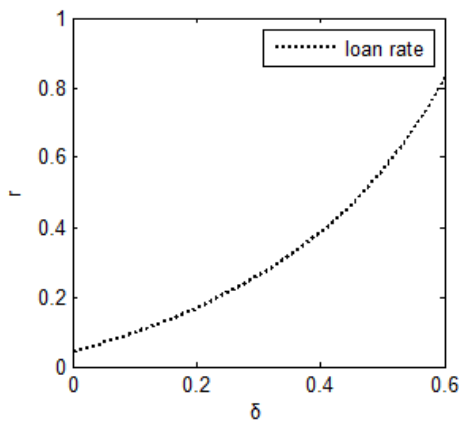
Figure 3.The impact of manufacturer's default rate δ on loan interest rate

As shown in Figure 4, The failure of the core business makes small and medium-sized logistics enterprises can not repay in time can not recover the rest of the money, which will cause a huge loss of business the logistics business. So the rise in the manufacturer's default rate leads to the logistics business services pricing gradually increased. At $\delta=0.35$, the service price of small and medium-sized logistics enterprises increased significantly. Indicating that the default rate reach to a certain extent, the small and medium-sized logistics

enterprises will significantly raise prices to maintain their own interests and to achieve a certain warning effect.
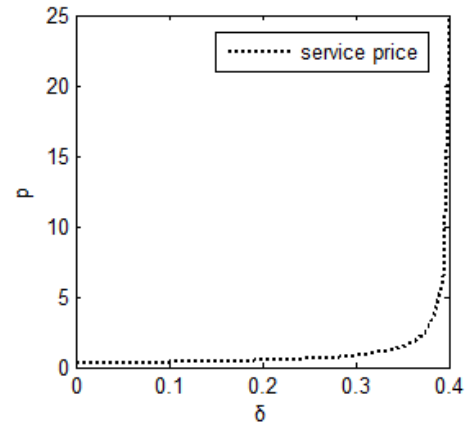
Figure 4.The impact of manufacturer's default rate on service price

As can be seen from Figure 5 and Figure 6, the increase in the manufacturer's default rate will reduce the financing benefits of small and medium-sized logistics enterprises and banks. When $\delta > 0.15$, banks and small and medium-sized logistics companies are almost unable to obtain any gains from financing. Therefore, the banks in the selection of manufacturers and small and medium-sized logistics enterprises to carry out financing business should consider the manufacturer's credit rating and determine its default rate of not more than 15%. In order to maximize the profits, banks should ensure that the default rate of manufacturers is less than 5.
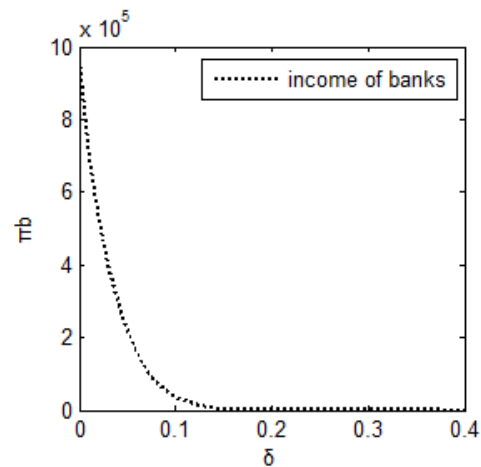
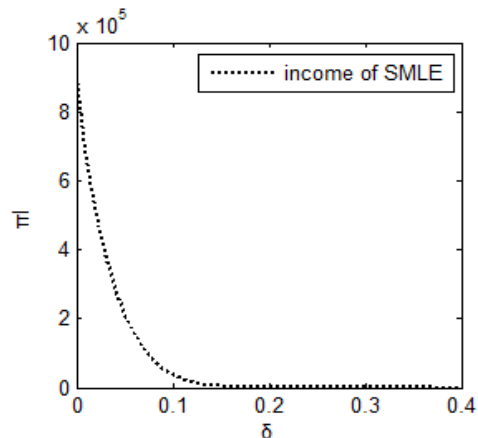Figure 5. The impact of manufacturer's default rate δ on bank earnings

Figure 6. The impact of manufacturers' default rate δ on the return of logistics enterprises

V. CONCLUSION

This paper constructs the financing model of accounts receivable in small and medium-sized logistics enterprises from the perspective of supply chain finance analyzes its financing subject and operation process. The Stackelberg game model is used to deduce the financing income of small and medium-sized logistics enterprises and banks, determine the optimal pricing for both parties, quantify the financing process of this financing model. Through the data simulation, it is verified that the focus of financing of accounts receivable in small and medium-sized logistics enterprises under the background of supply chain finance is the manufacturer default rate. This model can provide advice for the bank financing business and broaden the financing channels for small and medium enterprises. But there are many shortcomings in this article. In order to simplify the model, we only consider the small and medium-sized logistics enterprises and the bank's financing income and didn't consider the manufacturer's revenue. Then more risk factors can be added to the model to consider as the direction of further research.

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