

THE PRICING MECHANISM OF SUPPLIERS IN RISK-SHARING IN EXTERNAL FINANCING

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Abstract: In the background of retailers financing to financial institutions because of lacking of fund, assume that suppliers are risk-averse and it costs much to rebuild the network of retail outlets, the paper uses utility function to deduce the best wholesale prices for suppliers in risk-sharing. Research shows that suppliers will avoid financing risks at high wholesale price in risk-sharing. And it also shows the influence mechanism of the wholesale price.

1 PREFACE

1.1 About External Financing

It is an important puzzle in current supply chain management that how to coordinate the relationship between logistics, funding flow and information flow effectively. Modigliani and Miller(1958) pointed that financial decision making was irrelevant to production capability/decision to produce in complete competition environment, so financial decision making and operating decision making could separate. So it concentrates in the coordination between material flow and information flow such as Lee and Whang (1992). Those conclusions are based on amply supported with funds. But in a competitive global economy and national market competition, it is hard to fulfill, Thomus (2002) pointed the capital restraint would affect operating decisions, price and production of the enterprise. But without consideration of the interaction of decision making in financial and operation, meanwhile, the conclusion that financial decision making and operating decision making can separate may not be tenable(Chen and Wan(2008)).As a result, more and more scholars begin to pay attention to codetermination of financial and operation. The financing in supply chain caused wide attention.

In model study, past studies have focused on an individual company such as Hu and Sobiel (2005) used dynamic newsboy model to study the interaction of capital composition and operating decision. Xu and Brige (2005) used newsboy to analyze the best output decision of enterprise under limitation of funds and incentive mechanism to manager. Chen and Wan (2007) used merchant agreement and loan agreement to study the influence of financing service on supply chain enterprise operating decision and value. Caldenty and Chen (2008) studied financing service value in purchasing contract and the influence of financing service on the value of financing enterprise. Chen Xiangfeng studied the best ordering policy and the profit of supply chain enterprise of which the retailers borrow money from financial institutions in lacking sufficient funds. But he only considered the allocation of risks between retailers and financial institution without considering suppliers. The paper has considered suppliers to share risks based their studies and calculated the best wholesale price and the influence mechanism of wholesale price.

1.2 The Necessary of the Research and Relevant Conclusions

In developing countries, medium-sized and small

enterprises usually face shortage of funds. Financing becomes the survival guarantee of medium-sized and small enterprises. Financing can be divided into external financing and internal financing. This paper mainly considers external financing. In external financing, most papers focus on retailers and financing institutions need undertake the risk of indeterminacy demand. Obviously, it is unfair to retailers. In the operation of supply chain, only in equitable and efficient allocation of risks can the supply ensure high-efficient development.

It costs large manual labor and material resources to rebuild the network of retail outlets, leading that under normal circumstances suppliers don't want to see the retailers go broke. Assume that suppliers are rational agents and risk-averse. Suppliers will help the retailers share risks to avoid the retailers going broke because these risks are insignificant to key suppliers and it can achieve win-win.

This paper is under the two background conditions. Consider suppliers as rational agents to share financing risks of retailers to calculate equation and influence mechanism of wholesale price and contrast with that of non-risk-taking.

2 PROBLEM DESCRIPTIONS AND MODEL HYPOTHESES

2.1 Problem Descriptions

Considering secondary structure of supply chain, a single supplier serves a single retailer. In the initial sale, if retailers appear limitation of funds, they can attain financing service from competitive capital market. Chen Xiangfeng's study demonstrated that suppliers are the biggest beneficiaries when cooperation and risk-taking between retailers and financing institutions are only considered. And he deduced the best wholesale price of suppliers and its influence mechanism. On that basis, considering the large cost of rebuilding of regional retail network, suppliers will initiatively share financing risk in external financing to avoid the bankruptcy risk of retailers.

2.2 Model Hypotheses and Nomenclature

Assume that a single supplier provides a single kind of product to a single retailer newsboy characterized, wholesale price is w , import price of the suppliers

is c ; there is limitation of funds in adoption process for retailers and its own purchase fund is B . Market demand D is uncertain, its density function is set as $f(D)$. CDF(cumulative distribution function) is $F(D)$, and $F(D)$ is continuous, derivable and strict increase. And $\overline{F(D)} = 1 - F(D)$. Assume that $F(D)$ has a certain mean value \overline{D} , $F(D)$ accords with a distribution of increasing failure rate.

At the beginning of the sales cycle, cash-strapped retailers can attain financing service in the competitive capital market and accept the merchant agreement from suppliers through ordering Q and paying wQ . Then, retailers sell on the market at the fixed retail price $w \leq p$, and the profit is $p \cdot \min[D; Q]$.

At the end of the sales cycle, the retailers will return principal and interest of financing to the financial institution who offered financing service to them.

In order to explain the model clearer, the paper assumes as follows,

Assumption 1, goods have little marketable value after sales cycle.

Assumption 2, financial institutions especially banks face drastic market competition, so many financial institutions will offer financing service to cash-strapped enterprises so as to achieve financing profit, and the financing rate is r .

Assumption 3, financial institutions that offer financing service are investors that pursue risk neutral and are in competitive capital market. The average market rate of return on investment in capital market is r_f , or risk-free rate of the capital market. And it is determined by the competition of market. The more intense the competition of market is, the smaller r_f is.

Assumption 4, the suppliers and the retailers are both rational agents. To suppliers, if the retailers go broke, it is necessary to rebuild the regional retail net. And the reproduction cost is K it is high in general.

Assumption 5, the suppliers are risk-averse and HARA rate is α .

Figure 1 states that the retailers and the fund raising institutions share the financing risks. The dotted line states that the suppliers, the retailers and the fund raising institutions share the financing risks.

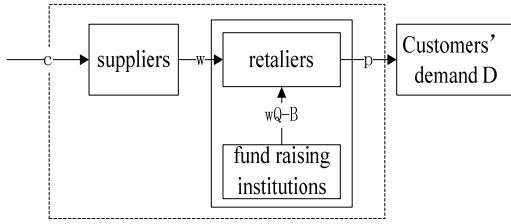


Figure 1.

3 RISK-SHARING PRICING STRATEGIES FOR SUPPLIERS

According to assumptions made before, at the beginning of sales cycle, the retailers with inadequate capital could afford wQ to suppliers with capital of amount B from themselves as well as $L_0 = wQ - B$ from financing; At the end of the sales cycle, the retailers will get profits of amount $p \cdot \min[D; Q]$, and clear the debts in the bank account by paying back $\min[p \cdot \min[D; Q]; L_1]$, where $L_1 = L_0(1 + r)$.

Therefore, retailers should order the optimal amount for sales to optimize their benefits, and the expected earnings should be:

$$\pi_F^R = E[p \min[D, Q] - (wQ - B)(1 + r)] ;$$

From the formula above we can see that under the assumption of existence of financial service, the retailers' net income will be positive while the profits from sales " $p \cdot \min[D; Q]$ " is larger than the amount of principal and interest owed to the financial institute. Otherwise, the company would end up with bankruptcy, after which the profits will, of course, be zero. The optimal-ordering strategy and the corresponding probability of bankruptcy of retailers can be described by Proposition 3.1.

Proposition 3.1

The optimal-ordering amount for a capital-limited retailer who can finance in the competitive capital market is

$$Q_F^* = \bar{F}^{-1} \left[\frac{w(1 + r_f)}{p} \right].$$

Under this optimal-ordering amount the bankruptcy probability of the retailer is

$$F_1 = F \left[\frac{(wQ_F^* - B)(1 + r_f)}{p} \right]$$

Proof:

The proof for optimal-ordering amount was given by Chen X.(2008). And under this optimal-ordering amount, the profit of the retailer is:

$$\pi_F^R = E[p \min[D, Q] - (wQ - B)(1 + r)] \quad (1)$$

If the retailer comes to bankruptcy, obviously we have

$$p \min[D, Q] - (wQ - B)(1 + r) \leq 0 \quad (2)$$

The retailer will not apply the sale plan if the retailer would still end up with bankruptcy even while the real sales amount reaches the optimal-ordering amount. So this is not realistic and from (2) we can get

$$D \leq \frac{(wQ - B)(1 + r)}{p} \quad (3)$$

So the bankruptcy probability is

$$F_1 = F \left[\frac{(wQ_F^* - B)(1 + r_f)}{p} \right].$$

Proved.

Obviously, this probability is an increasing function with respect to the risk-free interest rate and a decrease function with respect to the capital B owned by the retailer.

Now, the expectation of profits for the retailer is:

$$\begin{aligned} E(\pi_F^S) &= (w - c)Q_F^*(1 - F_1) + F_1[(w - c)Q_F^* - K] \\ &= (w - c)Q_F^* - F_1K \end{aligned} \quad (4)$$

The variance of profits is:

$$\begin{aligned} Var(\pi_F^S) &= (1 - F_1)[E(\pi_F^S) - (w - c)Q_F^*]^2 \\ &+ F_1[E(\pi_F^S) - (w - c)Q_F^* + k]^2 = F_1K^2 + F_1^2K^2 \end{aligned} \quad (5)$$

Proposition 3.2

While the distribution function of market demand $F(D)$ satisfies the property of failure-rate-increase, with the competitive financial market that is able to serve for retailers of inadequate funds, the pricing strategy of a risk averse supplier while considering to reestablish the network for sales after bankruptcy of the retailers should be a fixed value w , which should be larger than the value w_1 obtained without taking into consideration the reestablishment of the network.

Proof:

Without considering the reestablishing of network, the pricing equation (see Xiangfeng, 2008) should be

$$1 = \frac{1}{H(Q_F^*)} \left(1 - \frac{c}{w}\right) \tag{6}$$

Here $H(Q_F^*) = Q_F^* \frac{f(Q_F^*)}{F(Q_F^*)}$ is the general failure

rate.

The supplier is risk averse, and satisfies the mean-variance utility function, which is

$$U = E(\pi_F^S) - \frac{\alpha}{2} Var(\pi_F^S) \tag{7}$$

Obviously $\frac{\partial^2 U}{\partial w^2} < 0$, so there must exist w_1 , such that (7) has maximum value. w_1 is the solution of the equation?

$$\frac{\partial U}{\partial w} = -Q_F^* \left[\frac{1}{H(Q_F^*)} \left(1 - \frac{c}{w}\right) - 1 \right] - f_1 f \left[\frac{(wQ_F^* - B)(1+r_f)}{p} \right] \frac{Q_F^*(1+r_f)}{p} \left(1 - \frac{1}{H(Q_F^*)}\right) = 0 \tag{8}$$

Here $f_1 = f_1(K, \alpha) = K + \frac{\alpha}{2} K^2 - \alpha F_1$

$$H(Q_F^*) = Q_F^* \frac{f(Q_F^*)}{F(Q_F^*)}$$

$$\text{Set } M = f_1 f \left[\frac{(wQ_F^* - B)(1+r_f)}{p} \right] \frac{(1+r_f)}{p}$$

Then we have

$$1 - M = \frac{1}{H(Q_F^*)} \left(1 - M - \frac{c}{w}\right) \tag{9}$$

Without considering the network for sales after bankruptcy of retailers, the price w_1 satisfies

$$1 = \frac{1}{H(Q_F^*)} \left(1 - \frac{c}{w}\right) \tag{10}$$

For the sake of convenience, assuming that $f(D)$ follows an exponential distribution, we can easily get $w > w_1$. Proved.

The research shows that while the suppliers take into account the cost for the reestablishment of sales network, they may control the ordering amount of retailers as well as avoid the potential over storage problem resulted from the shrinking of demand by setting a higher wholesale price. Then they can hedge for the risk of bankruptcy of retailers. In this process, the suppliers get involved in the financing step of retailers. So the optimal wholesale price will be determined by the capital amount B owned by retailers and by the competitive level of the capital

market, denoting by r_f .

Proposition 3.3

While suppliers take into account the cost of reestablishment of sales network, the optimal wholesale price aiming at hedging for the risk of bankruptcy of retailers will be negative related with the funds amount B owned by retailers, and be positive related with the competitive level of the capital market, denoting by r_f . And it will also be positive related with the absolute risk-aversion coefficient α of suppliers.

Proof:

Since w is the solution of

$$1 - M = \frac{1}{H(Q_F^*)} \left(1 - M - \frac{c}{w}\right)$$

After calculation we can easily get

$$\frac{\partial w}{\partial B} < 0; \frac{\partial w}{\partial r_f} > 0; \frac{\partial w}{\partial \alpha} > 0$$

So the optimal price designed while considering the share of financing risk should be negative related with the funds amount B owned by retailers, and be positive related with the competitive level of the capital market, denoting by r_f . And it will also be positive related with the absolute risk-aversion coefficient α of suppliers.

4 CONCLUSIONS AND PROSPECT

Based on ideas of utility function, we discussed the pricing strategies for suppliers in a double supply chain while the suppliers have to share the financial risk from the retailers with inadequate funds. We concluded that the optimal-ordering amount for a capital-limited retailer who can finance in the competitive capital market is a fixed value. And we also find that taking the high cost for reestablishment of sales network into consideration, a risk adverse supplier will push the rational retailers to cut off their order by setting a high wholesale price, by which they can hedge for the risk of bankruptcy of retailers. At the same time, our calculation shows that the optimal price should be negative related with the funds amount B owned by retailers, and be positive related with the competitive level of the capital market, denoting by r_f . And it will also be positive related with the absolute risk-aversion coefficient α of suppliers.

There are still some limitations in our paper. We assume the market demand following an exponential distribution, which is not necessarily true. And in reality, suppliers always try to increase their sales to gain market share, so the suggestion of hedging for risk by setting higher wholesale price may not be realistic. The upcoming research may consider the strategies of sharing the financial risk of retailers with other suppliers, such as recycling the unsold goods or economic assistance to the bankrupted retailers. What's more, we only make our discussion under the secondary supply chain structure. To extend the results into a three-tier (or more) supply chain structure, the adjustments for production and sale according to financing activities from different levels of the supply chain may deserve further discussion.

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