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An Agency Model to Explain Advance Payment Contract in Supply Chain Management

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Abstract: Advance payment plays an important role in both domestic and international transactions. In order to find out the influence of the advance payment on the product quality and the retailer's moral hazard, an agency model is explored in the research. The results show that, the advance payment can mitigate the moral hazard of the retailer and can improve the product quality, but can't make them optimal. By the way, conditions for advance payment are listed, which is referred to the opportunity cost margins of the supplier and the retailer. At last, a revenue sharing contract with advance payment is given to coordinate the supply chain.

Key words: Advance payment, product quality, supply chain coordination, agency theory

INTRODUCTION

Trade credit has been seen as an important source for the firms to get financial support, especially for which are out of bank credit (Giannetti, 2003). Of course, trade credit is not only used for financial purses, for example it can be used as a certification of product's quality (Giannetti *et al.*, 2011). Advance payment (prepayment or early payment) is a kind of trade credit in which the buyers pay the money before the delivery. The scarcity of studies regarding advance payment is surprising, especially since according to IMF (2009) study, advance payment happens in 19-22% of international transactions.

An agency model is developed by Bastos and Pindado (2007), which is for explaining the adverse selection and moral hazard problems. Following Bastos and Pindado (2007) the research use the agency theory to explore the existing problems with advance payment contract. Previous empirical work has suggested that trade credit can be viewed as a contractual solution to concern product quality (Ng *et al.*, 1999). Just as Pike *et al.* (2005) point out, the relationship between the advance payment contract and the product quality is more complex. This leads to the first research question: what is the relationship between the advance payment contract and the product quality.

A second way of viewing trade credit is as part of the firms' mechanisms to mitigate the overall damage due to the buyer's moral hazard?

Repullo and Suarez (2000) think the moral hazard problem between the firms and their lenders can be mitigated by credit trade. Bastos and Pindado (2007) arise a moral hazard model in advance payment model, from the

ex-post asymmetric information between suppliers and buyers, which gives rise to the possibility that clients will not pay when payment is due. Giannetti *et al.* (2011) consider to mitigate the buyer's moral hazard problem is one of the reasons that the suppliers offer more trade credit. So the second question to explore is: whether can the advance payment mitigate the buyer's moral hazard problem or not.

This study proposes a simple agency model to explore the above two questions. The research extends the models from two aspects. First, the trading volume between the supplier and the retailer is the demand quality, other than one (Bastos and Pindado, 2007; Giannetti *et al.*, 2011), which consists with the truth. Second, it is wanted to know how the advance payment influences the product quality, so the product quality can be verified after the contract. The supplier can partly control the product quality by putting effort (Kaya, 2011). So, the product quality is used by a moral hazard parameter. The model can be seen as double sided moral hazard.

METHODOLOGY

As explained above, the demand is dependent on the retailer's sales effort e and the supplier's product quality s , as $Q = Q(e, s)$. It is assumed that the cost for retailer of providing effort level e is $g(e)$, where, $g(0) = 0$, $g'(e) > 0$, $g''(e) \geq 0$. The supplier's unit producing cost is influenced by the product quality, it is assumed as $c(s)$, where $c(0) = 0$, $c'(s) > 0$, $c''(s) \geq 0$. The quality equals to zero, means there is no product to provide, so the cost is also zero.

The sales effort and the quality can both enhance the demand, as:

$$\frac{\partial Q}{\partial e} > 0, \frac{\partial Q}{\partial s} > 0$$

But both margins are decreasing, as:

$$\frac{\partial^2 Q}{\partial e^2} \leq 0, \frac{\partial^2 Q}{\partial s^2} \leq 0$$

The sales effort and the product quality can improve each other's influence, as:

$$\frac{\partial^2 Q}{\partial e \partial s} > 0$$

The product's market price p is fixed. The retailer pays A to the supplier before the delivery, so the supplier charges $w(A)$ per unit product. The advance payment discount is dependent on the amount which the retailer pays in advance and the more the retailer pays in advance, the more discount the supplier provides, as $w'(A) < 0$. Let $k_r(A)$ denote the opportunity cost of the retailer providing the advanced payment, where $k_r(0) = 0$, $k_r'(A) > 0$. Let $k_s(A)$ denote the opportunity cost of the supplier getting the advance payment, where $k_s(0) = 0$, $k_s'(A) > 0$. As Giannetti *et al.* (2011) figure out, to some extent, firms have some financial slack or unused credit facilities enabling them to take advantage of the discount offers. So the opportunity cost of the retailer is always less than that of the supplier, $k_r(A) < k_s(A)$ and the margin of the advance payment for the retailer is less than that for the supplier, $k_r'(A) < k_s'(A)$.

Following the integrated supply chain model will be explored. The sales effort and the product quality in the integrated supply chain, as the best ones, will be listed as a benchmark.

Under these assumptions, the profit of the whole channel can be expressed as follow:

$$\pi_t = pQ(e, s) - c(s)Q(e, s) - g(e) \quad (1)$$

Where, from the second order conditions, it is easy to get the Hessian Matrix is negative. The first best sales effort and the first best product quality can be gotten, when the first order conditions equal to zero. The first best sales effort and the first best product quality can be gotten from the following Eq:

$$p \frac{\partial Q(e^*, s^*)}{\partial e^*} = g'(e^*) \quad (2)$$

$$(p - c(s^*)) \frac{\partial Q(e^*, s^*)}{\partial s^*} = c'(s^*)Q(e^*, s^*) \quad (3)$$

where, for the advance payment contract, the supplier provides a list pairs of advance payment and whole sale price, as $\{A, w(A)\}$, where, $A \in [0, \bar{A}]$, $w \in [\underline{w}, \bar{w}]$ and $w(0) = \bar{w}$, $w(\bar{A}) = \underline{w}$, $\bar{A} \leq \bar{w}Q$ which means the most advance payment is no more than the total transfer amount. The retailer chooses the amount from the list, which he wants to pay in advance.

Under these assumptions, the supplier can decide his product quality and the wholesale price to maximize his profit. The supplier's profit is listed as following:

$$\pi_s(s, w(A)) = w(A)Q(e, s) + k_s(A) - c(s)Q(e, s) \quad (4)$$

The supplier's first order conditions are as following:

$$\frac{\partial \pi_s}{\partial A} = w'(A)Q(e, s) + k_s'(A) \quad (5)$$

$$\frac{\partial \pi_s}{\partial s} = (w(A) - c(s)) \frac{\partial Q(e, s)}{\partial s} - c'(s)Q(e, s) \quad (6)$$

Because $w'(A) < 0$, $k_s'(A) > 0$, from Eq. 5:

$$k_s'(A) > -w'(A)Q(e, s) \quad (7)$$

where, if and only if Eq. 7 is satisfied, the supplier will provide this advance payment contract. From Eq. 6, the supplier will choose a suitable product quality to maximize his profit, so:

$$\frac{\partial \pi_s}{\partial s^A} = 0$$

The superscript A is used for the parameter under the advance payment contract.

From the retailer's aspect, he will choose his sales effort and the advance payment amount to maximize his profit and the retailer's profit is as following:

$$\pi_r = pQ(e, s) - w(A)Q(e, s) - k_r(A) - g(e) \quad (8)$$

The retailer's first best conditions are as following:

$$\frac{\partial \pi_r}{\partial A} = -w'(A)Q(e, s) - k_r'(A) \quad (9)$$

$$\frac{\partial \pi_r}{\partial e} = (p - w(A)) \frac{\partial Q(e, s)}{\partial e} - g'(e) \quad (10)$$

where, the retailer will choose his sales effort to maximize his profit, that is:

$$\frac{\partial \pi_r}{\partial e^A} = 0$$

The condition for that the retailer chooses to pay in advance is Eq. 9 more than zero. So, it can get:

$$k_r(A) < -w'(A) Q(e, s) \quad (11)$$

RESULTS AND DISCUSSION

Proposition 1: If the opportunity cost margins of the supplier and the retailer satisfies $k_r(A) < -w'(A) Q(e, s) < k_s'(A)$, both the supplier and the retailer will agree with the advance payment contract.

Proposition 1 shows the financial conditions for the advance payment. Then the influence of advance payment on product quality and the sales effort will be discussed.

Figure 1 shows how the advance payment influences the product quality and the sales effort. Figure 1a shows how the product quality changes with the advance payment. Figure 1b shows how the sales effort changes with the advance payment.

In Fig. 1a, s^0 is the product quality when the advance payment is zero, which means there is no advance payment. In Fig. 1b, e^0 is the sales effort when the advance payment is zero, which means there is no advance payment.

Proposition 2: The product quality will be improved under the advance payment contract.

Proof: Under Eq. 5:

$$\frac{\partial \pi_s}{\partial A} > 0$$

where, from Eq. 6, the second order condition of the product quality is as following:

$$\frac{\partial^2 \pi_s}{\partial s^2} = (w(A) - c(s)) \frac{\partial^2 Q(e, s)}{\partial s^2} - 2c'(s)Q(e, s) - c''(s)Q(e, s) < 0 \quad (12)$$

Because:

$$\frac{\partial \pi_s}{\partial s^A} = 0$$

and the second order condition, so:

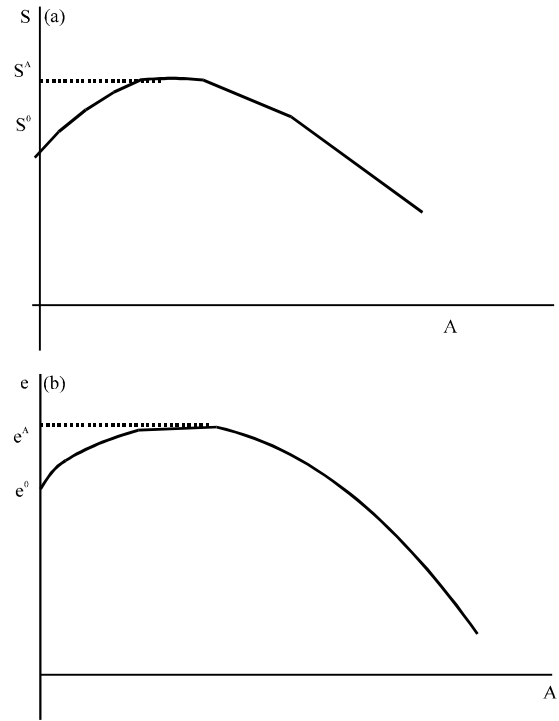


Fig. 1(a-b): Influence of the advance payment (a) Relationship between the product quality and the advance payment, (b) Relationship between the sales effort and the advance payment

$$\frac{\partial \pi_s}{\partial s} > 0$$

when $s < s^A$ and:

$$\frac{\partial \pi_s}{\partial s} < 0$$

when $s > s^A$:

$$\frac{\partial \pi_s}{\partial A} = \frac{\partial \pi_s}{\partial s} = \begin{cases} > 0, \text{ where } s < s^A \\ < 0, \text{ where } s > s^A \end{cases}$$

So the draft Fig. 1 for the relationship between the product quality and the advance payment can be shown as Fig. 1a.

From Fig. 1a, it can be clearly gotten as $s < s^A$, so the advance payment contract can improve the product quality.

Proposition 3: The retailer's moral hazard can be mitigated by advance payment.

Proof: Under Eq. 9:

$$\frac{\partial \pi_r}{\partial A} > 0$$

where, From Eq. 10, the second order condition of the sales effort is as following:

$$\frac{\partial^2 \pi_r}{\partial e^2} = (p - w(A)) \frac{\partial^2 Q}{\partial e^2} - g''(e) < 0 \quad (13)$$

Because and the second:

$$\frac{\partial \pi_r}{\partial e} > 0$$

d order condition, so:

$$\frac{\partial \pi_r}{\partial e^A} = 0$$

when $e < e^A$ and:

$$\frac{\partial \pi_r}{\partial e} < 0$$

when $e > e^A$:

$$\frac{\partial \pi_r}{\partial A} = \frac{\partial \pi_r}{\partial e} = \begin{cases} > 0, \text{ where } e < e^A \\ < 0, \text{ where } e > e^A \end{cases}$$

So the draft Fig. 1 for the relationship between the sales effort and the advance payment can be shown as Fig. 1b.

From Fig. 1b, it can be clearly gotten as $e^A > e^0$, so the advance payment contract can mitigate the retailer's moral hazard.

The product quality and the sales effort cannot reach the first best, so the supply chain can't be coordinated by the advance payment contract.

Proposition 4: Advance payment cannot coordinate this supply chain alone.

COORDINATION CONTRACT

From the previous analysis, the advance payment contract can't coordinate the supply chain. In this section, the effort is made to design a contract to coordinate it. As Hou *et al.* (2009) mention, the revenue-sharing contract can align the two parties' interests and actions by having the retailer share a portion of his revenue with the supplier.

Considering the revenue sharing contract, the supplier charges $w_r(A)$ per unit purchased plus the retailer gives the supplier a percentage of the revenue. Let α be the fraction of revenue the supplier earns, so $1-\alpha$ be the fraction of revenue the retailer keeps. The advance payment A should be dependent on the total transfer amount, it is simplified to be $A(Q)$, where $A(0) = 0$, $A'(Q) > 0$.

The supplier's profit function is:

$$\pi_s = (1-\alpha)pQ(e,s) + w(A(Q))Q(e,s) - k_s(A(Q)) - c(s)Q(e,s) \quad (14)$$

And the first order condition is:

$$[(1-\alpha)p - c(s) + k_s'(A) + w'(A)Q + w] \frac{\partial Q}{\partial s} = c'(s)Q \quad (15)$$

The retailer's profit function is:

$$\pi_r = \alpha pQ(e,s) - w(A(Q))Q(e,s) - k_r(A(Q)) - g(e) \quad (16)$$

The first order condition is:

$$[\alpha p - k_r'(A) - w'(A)Q - w] \frac{\partial Q}{\partial e} = g'(e) \quad (17)$$

By comparing 15 with 3, 17 with 2, the optimal contract parameters are as following:

$$A' = \frac{(1-2\alpha)p}{k_r' - k_s'} \quad (18)$$

$$w' = \frac{[\alpha k_r' - (1-\alpha)k_s']p - w}{(1-2\alpha)p} \quad (19)$$

Considering Eq. 18, because $A'(Q) > 0$ and $k_s' > k_r'$, so $\alpha > \frac{1}{2}$. Because $A(0) = 0$, so:

$$A(Q) = \frac{(1-2\alpha)p}{k_r' - k_s'} Q = \frac{(1-2\alpha)}{k_r' - k_s'} pQ \quad (20)$$

Considering 19, because $w' < 0$:

$$\left(\text{as } \frac{\frac{w}{p} + k_s'}{k_r' + k_s'} > \frac{k_s'}{k_r' + k_s'} > \frac{1}{2} \right)$$

so:

$$\alpha > \frac{\frac{w}{p} + k_s'}{k_r' + k_s'} \quad (21)$$

The supplier should get a non-negative profit, so:

$$\alpha > \frac{p-c+w}{p} + \frac{k_s}{pQ} \quad (22)$$

Proposition 5: The supply chain can be coordinated, when Eq. 19-22 are satisfied.

CONCLUSION

This research extends the previous models from two aspects. First, the trading volume between the supplier and the retailer is the demand quantity, other than one (Bastos and Pindado, 2007; Giannetti *et al.*, 2011), which consists with the truth. Second, the product quality is considered to be verified after the contract. The supplier can partly control the product quality by putting effort (Kaya, 2011). So the product quality is used by a moral hazard parameter. The model explored can be seen as double sided moral hazard.

Three main results are reached. First, conditions from the financial aspect for advance payment are listed, which is referred to the opportunity cost margins of the supplier and the retailer. Second, the advance payment do mitigate the moral hazard of the retailer and improve the product quality, but can't make them first best. Third, a revenue sharing contract with advance payment is given to coordinate the supply chain.

The product quality not only can be seen as a moral hazard factor (Kaya, 2011), but also can be seen as the asymmetric information (Bastos and Pindado, 2007). There will be different results if the product quality considered as the asymmetric information. Of course, the better results will be reached by considering both. Other limitation in this model, is the demand quantity equals to the order quantity. Although it happens in reality, the contract usually has been designed before ordering.

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REFERENCES

- Bastos, R. and J. Pindado, 2007. An agency model to explain trade credit policy and empirical evidence. *Applied Econ.*, 39: 2631-2642.
- Giannetti, M., 2003. Do better institutions mitigate agency problems? Evidence from corporate finance choices. *J. Financial Quantitative Anal.*, 38: 185-212.
- Giannetti, M., M. Burkart and T. Ellingsen, 2011. What you sell is what you lend? Explaining trade credit contracts. *Rev. Fin. Stud.*, 24: 1261-1298.
- Hou, J., A.Z. Zeng and L. Zhao, 2009. Achieving better coordination through revenue sharing and bargaining in a two-stage supply chain. *Comput. Ind. Eng.*, 57: 383-394.
- IMF, 2009. World economic outlook, April 2009: Crisis and recovery. International Monetary Fund, <http://www.imf.org/external/pubs/cat/longres.aspx?sk=22575>.
- Kaya, O., 2011. Outsourcing vs. in-house production: A comparison of supply chain contracts with effort dependent demand. *Omega*, 39: 166-178.
- Ng, C.K., J.K. Smith and R.L. Smith, 1999. Evidence on the determinants of credit terms used in interfirm trade. *J. Finance*, 54: 1109-1129.
- Pike, R., N.S. Cheng, K. Cravens and D. Lamminmaki, 2005. Trade credit terms: Asymmetric information and price discrimination evidence from three continents. *J. Bus. Finance Account.*, 32: 1197-1236.
- Repullo, R. and J. Suarez, 2000. Entrepreneurial moral hazard and bank monitoring: A model of the credit channel. *Eur. Econ. Rev.*, 44: 1931-1950.