

# *Research on Factors' Risk Management on Reverse Factoring*

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**Keywords:** Commercial factoring, Reverse factoring, Supply chain finance, Receivables financing, Credit risk

**Abstract:** Reverse factoring solves the financing problem of SME suppliers through the higher reputation of the core firm in the supply chain. A two-stage three-party supply chain model is constructed and optimized, from which find that reverse factoring can not only mitigate the financing difficulties of SME, but also improve the overall efficiency of the supply chain. The risk of reverse factoring mainly comes from the credit risk of the core enterprise, the countermeasures are proposed to prevent the credit risk.

## 1. Introduction

In the supply chain, SME suppliers have financing difficulties due to data lackness and insufficient collateral. Reverse factoring, as an innovation instrument, helps to solve the financing problem of SME suppliers through superior credit guarantee of the core firm (buyer) in the supply chain. According to IFA, the reverse factoring amount increased from 54.5 billion euros to 186.5 billion euros from 2017 to 2022, with an average annual growth rate of 27.9%. At the same time, the factors' risk management on reverse factoring has become a valuable research issue.

Yongwang Guo and Guobin Deng (2016) conclude that the traditional commercial factoring has credit risk from both buyers and sellers, performance risk from downstream firms, real transaction risk, duplicate transaction and fraud risk, and propose corresponding risk prevention strategies<sup>[1]</sup>. Zhongjie Sun and Hui Yu (2018) utilize Stackelberg game to prove that reverse factoring can improve the overall efficiency and stability of the supply chain, and the core firm benefit more, which provides a reasonable explanation for their participation in reverse factoring<sup>[2]</sup>. Research by Zhongjie Sun and Hui Yu (2020) shows further that Robust decision-making provides an effective decision-making for factoring faced by uncertain demand<sup>[3]</sup>. Panos Kouvelis, Fasheng Xu(2021)developed a supply chain theory of factoring(recourse ,non-recourse and reverse factoring), found that reverse factoring will be efficient for the whole supply chain if the supplier's credit rating is lower than that of the retailer<sup>[4]</sup>. Jie Zhang et al. (2023) solved the optimal production decisions and credit periods of downstream distributors by constructing a reverse factoring financing decision model for agricultural technology-based SME<sup>[5]</sup>.

## 2. Analysis of Risk Management Model of Reverse Factoring

### 2.1. Model Description

This model analyzes the supply chain of commodity transaction, in which retailers are the core enterprises and suppliers are SME (Figure 1). Assuming that the SME suppliers in the supply chain have difficulty in financing, the retailers order at the maximum outputs, so the order lots will be not considered. Further assuming that suppliers will not change prices frequently and the dominant risk comes from market demand risk. Here we focus on two different situations: supply chain under financing constraint and reverse factoring respectively.

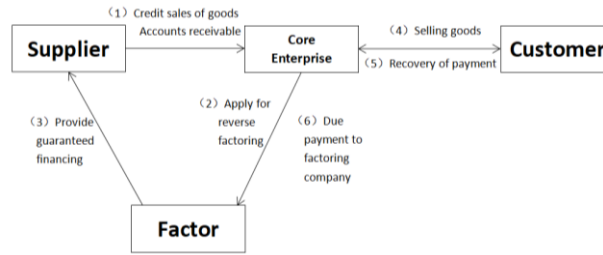


Figure 1: Financial Flow Chart of Reverse Factoring Supply Chain.

#### Symbolic description:

C: Unit cost of the supplier;

W: The supplier's supply price;

$\eta$ : Supplier's self-owned funds;

$D = \frac{\eta}{C}$ : Retailer's order lots;

r: Factor's deduction rate;

P: Market price;

D: The market demand is a random variable, the density function is  $f(x)$  and the distribution function is  $F(x)$ ;

A: Core enterprise's self-owned funds

### 2.2. Supply Chain under Financing Constraints

Suppliers' expected profit

$$\pi_s = (W - C) \frac{\eta}{C} \quad (1)$$

Core enterprise's expected profit:

$$\pi_d = (P - W) \int_0^{\frac{\eta}{C}} xf(x)dx + (P - W) \frac{\eta}{C} \left(1 - \int_0^{\frac{\eta}{C}} f(x)dx\right) \quad (2)$$

Total expected profit of the supply chain:

$$\pi_s + \pi_d = (P - C) \frac{\eta}{C} + (P - W) \left( \int_0^{\frac{\eta}{C}} xf(x)dx - \int_0^{\frac{\eta}{C}} f(x)dx \right) \quad (3)$$

**Proposition 1: Under financing constraint, expected profits of SME suppliers, core enterprises and overall supply chain are all determined by the amount of SME suppliers' initial capital.**

Proof: From equation(1),  $\frac{d\pi_s}{d\eta} > 0$ , which means suppliers' expected profit is mainly constrained by its initial capital  $\eta$ . For SME suppliers, there are serious financing problems for future development. From equation (2), it can be found that core firms' expected profit is mainly affected by two factors: if  $D \leq \frac{\eta}{C}$ , it is determined by demand risk,  $(P - W) \int_0^{\frac{\eta}{C}} xf(x)dx$  is mainly determined

by  $f(x)$ ; if  $D > \frac{\eta}{c}$ , it is determined by initial funding from supplier,  $(P - W) \frac{\eta}{c} \left(1 - \int_0^{\frac{\eta}{c}} f(x) dx\right)$  is mainly determined by  $\eta$ . This is the reason for core firm to actively utilize reputation to help suppliers obtain accounts receivable factoring. Similarly, from formula (3), the efficiency of the whole supply chain is also restricted by the initial capital of SME suppliers when the demand is on the high side. End proof.

### 2.3. Supply Chain under Reverse Factoring

In order to break through the impact of SME suppliers' capitals on the overall efficiency of the supply chain, core firm can utilize their own reputation to help SME suppliers to obtain accounts receivable factoring. That is, SME suppliers can obtain  $\frac{\eta}{c}(1 - r)$  financing through reverse factoring. After the maturity of credit, core firm pays the loan  $\frac{\eta}{c}$  directly to the factor. To simplify the analysis, further assume that the sale of goods from suppliers is the sole source of revenue for the core firm, so its operating risks mainly come from the risk of market demand. Assuming that the probability of default is endogenous, the core firm will default only if its capital plus product sales revenue are insufficient to repay the factor. Let  $\rho$  represent the probability of default of the core firm, and the default condition can be written as  $A + DP \leq W \frac{c}{\eta}$ , namely  $D \leq \frac{W \frac{\eta}{c} - A}{P}$ .

$$\rho = \int_0^{\frac{W \frac{\eta}{c} - A}{P}} f(x) dx \quad (4)$$

**Proposition 2: With certain risk of demand, the core firm's capital can help to reduce its default risk. However, the higher proportion of accounts receivable factoring involved by the core firm, the higher risk of its default will be.**

Proof: the credit risk from reverse factoring is mainly reflected in the default propensity of the core firm. With certain risk of demand, the value of equation (4) is mainly determined by the upper limit of the integral  $\frac{W \frac{\eta}{c} - A}{P}$ .  $\rho$  changes in the opposite direction of  $A$  and in the same direction of  $\eta$ .  $A$  as the capital of core firm, acts as a buffer against loan risk. The supplier's capital  $\eta$  should not have affected the probability of default of the core firm, but in this case, it affected the probability of default by affecting the amount of accounts payable to be repaid by core firm. End proof.

Under the reverse factoring, a two-stage tripartite model is constructed, and the expected profit functions of three parties and the supply chain as a whole are as follows:

Expected profit of factor:

$$\pi_f = W \frac{\eta}{c} (1 - \rho) - W \frac{\eta}{c} (1 - r) = W \frac{\eta}{c} (r - \rho) \quad (5)$$

Expected profit from suppliers:

$$\pi_s = (W - C) \frac{\eta}{c} (2 - r) \quad (6)$$

Expected revenue of core enterprise:

$$\pi_d = (P - W) \int_0^{\frac{\eta}{c}(2-r)} x f(x) dx (1 - \rho) + (P - W) \frac{\eta}{c} (2 - r) \left(1 - \int_0^{\frac{\eta}{c}(2-r)} f(x) dx\right) \quad (7)$$

Total expected revenue of the supply chain:

$$\pi_s + \pi_d = (P - C) \frac{\eta}{c} (2 - r) + (P - W) \left( \int_0^{\frac{\eta}{c}(2-r)} x f(x) dx - \int_0^{\frac{\eta}{c}(2-r)} f(x) dx \right) \quad (8)$$

**Proposition 3** The expected profits of SME suppliers, core firms and the whole supply chain decrease monotonically with the reduction rate  $r$ , the whole supply chain efficiency is coordinated.

Proof: from equation (6),  $\frac{d\pi_s}{dr} = (W - C) \frac{\eta}{C} < 0$ . For the risk of demand is constant, derived from equation (7),  $\frac{d\pi_d}{dr} = (P - W) \frac{\eta}{C} \left(1 - \int_0^{\frac{\eta}{C}(2-r)} f(x) dx\right) < 0$ . As the expected profits of SMS suppliers and core firms decrease monotonically with the reduction rate, the overall efficiency of supply chain is consistent and coordinated. End proof.

**Proposition 4** Expected profit of factor increases monotonically with reduction rate. Under a factor-led contract, the reduction rate is determined by the risk of default of the core firm.

Proof: from the equation (5)  $\frac{d\pi_f}{dr} = W \frac{\eta}{C} > 0$ , expected profit of factor increases monotonically with deduction rate. Further derive equation (5) to get  $r = \frac{\rho-1}{1+r_f} + 1$ , where  $r_f$  is the expected yield rate of factor, which is determined by the supply and demand of funds in factoring market. In a fully competitive factoring market (which has a lower entry threshold, the fully competitive assumption is realistic), it is basically equal to the average profit margin. On this basis,  $\frac{dr}{d\rho} = \frac{1}{1+r_f} > 0$ , so deduction rate  $r$  increases monotonically with default probability of the core enterprise. End proof.

### 3. Credit Risk of Reverse Factoring and Countermeasures

To sum up, under circumstance of supply chain finance, reverse factoring can alleviate financing problem for SME suppliers, coordinate the capital flow and logistics, and improve the overall supply chain efficiency. Meanwhile, there is a possibility that the factor may suffer great losses due to business risks. In reverse factoring, factors' main risk come from credit risk.

#### 3.1. Credit Risk in Reverse Factoring

Credit risk includes buyer's credit risk, seller's credit risk and fraud risk. Fraud risk refers that buyers and sellers collude and cheat factor. Seller's credit risk is mainly caused by seller's failure to provide agreed goods on schedule, or the goods delivered are defective. Thus, the buyer may not pay for the goods, so that factor's funds cannot be recovered.

In practice, reverse factoring is mainly a non-recourse factoring. The seller no longer cares whether the buyer can pay the goods in time after selling accounts receivable to the factor. The first risk faced by factor is actually buyer's credit risk, which refers to the potential threat of bad debts faced by a factor if the buyer fails to meet its payment obligations.

#### 3.2. Countermeasures against Credit Risk

Most of factoring is non-recourse, which means that risk management of factors are mainly ex-ante. In reverse factoring, the key mechanism of factors' countermeasures against credit risk is to identify credit risk for buyers and sellers, and buyer's transaction risk in advance.

##### 3.2.1. Identification of Buyer's Credit Risk

A thorough customer survey ex-ante is necessary to avoid the loss due to information asymmetry. Factors need to pay high attention to risk identification of buyers, including analysis on financial statements, operating capacity, insolvency and other financial indicators of the retailers (core firm) in advance. Furthermore, large-scale and creditworthy enterprises are selected for further prudent judgment, so as to reduce the possible default risk caused by inferior firms. At the same time, different deduction rates are set for retailers with different ratings. For firms with higher ratings use

lower reduction rates and vice versa. The current reduction rate is generally set at 20%. While the debtor of receivables is a significant customer at the headquarters or branch level, or a Fortune 500 company with an external rating of BBB or above, the deduction rate may be appropriately reduced, but should not be less than 10%. For unrated firms, it is required to comprehensively judge their default risk based on capital status, operating scale, market risk, and set a reasonable reduction rate. In addition, it is also necessary to focus on examining whether the proportion of accounts receivable relative to the buyer's capital is reasonable, so as to further prevent the default risk of the core firm and reduce default losses.

### 3.2.2. Vendor Risk Identification

The ex-ante investigation for seller's risk need to be focused on capacity of supplier's execution of contract, i.e. whether the supplier can deliver goods with good quality and correct quantity on time. Suppliers are required to have superior corporate governance mechanism, strong contract execution ability and stable upstream and downstream supply relationship. At the same time, it is also necessary to review the historical transaction records of the buyer and seller, including the authenticity of transaction, transaction frequency, trade volume, payment term, whether there was any default or delay in delivery between two parties, and whether there was any unresolved lawsuit or dispute between two parties.

### 3.2.3. Investigation on Ownership of Accounts Receivable

As basic assets for the fulfillment of factoring, receivable accounts should be formed by the true transaction between creditors and debtors and in regular payment. Specifically, should include the following three aspects: firstly, examine whether the accounts receivable are true, legal and valid. Investigate the authenticity, validity and legality of the transactions, so as to avoid the unilateral forgery of documents to obtain financing; Secondly, factors should also review the relevant details, such as whether the accounts receivable are the legal property of the seller, whether the seller has the right to resell the accounts receivable to obtain financing , and whether the buyer is unable to repay the money due to the financial distress; Thirdly, the pledge of accounts receivable to a third party should be capable of inquiry through the "Unified Registration System for Chattel Financing" (Zhongdeng Net) set up by the credit information center of the People's Bank of China.

## Acknowledgement

**Funding:** Research on innovation performance improvement mechanism and realization path of professional, unique and superior enterprises in Shandong Province, 2023 Soft Science Project of Shandong Province (Project number: 2023RKY03009).

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