

The coordination mechanism of supply chain finance based on block chain

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Abstract: Recently, supply chain finance (SCF) through block chain platforms has gained its popularity. The modern supply chain has extremely extended, which leads to the nontransparency of the supply chain opacity, resulting in high cost of communication between upstream and downstream enterprises. In addition, the block chain, as the most ideal tool for rebuilding trust, can improve the enterprise's ability to control the supply chain, making efficient and accurate product traceability become a reality. We study an SCF system based on block chain platforms over a single period. Suppose that the supplier faces a capital supply restrict and must borrow capital through an online block chain platform. The block chain platform avoids risks through set service rate, guarantee fee, loan fee for the loan. We find that the optimal strategy of the participants in the SCF system is stackelberg. For a SCF system with a capital-supply-restrict supplier, we find that the Block chain platform service rate provided to the suppliers is related to the Supplier default rate and the loan amount of Block chain platform service to the supplier. Our analysis suggests that it is important for the supplier to take the online block chain platform's financial decisions (such as the service rate) into account when making their operational decisions.

1. Introduction

We made three major contributions to this article. First, the SCF theoretical model is built on the blockchain platform. Second, provide the best Stackelberg solution to the supply chain through capital-constrained suppliers or capital-constrained manufacturers. Third, we provide insights by analyzing the interaction between operational and financial decisions.

The rest of this article is organized as follows. Section 2 reviews relevant literature. Section 3 defines symbols and specific assumptions. The fourth part analyzes the best Stackelberg solution for the supply chain of restricted suppliers and manufacturers. Section 5 studies the interaction between business decision and financial decision based on the actual parameter values of small manufacturing enterprises in China.

2. Related literature

Supply chain finance and supply chain optimization are the focus of the stream of literature. Wesley S. Randall, M. Theodore Farris pointed out that the implementation of supply chain financing technology in cooperation with major trading partners can increase the profitability of all supply chain partners. Aberdeen-Group shows that in the relevant supply chain transactions, the strategy of shifting the financial burden to the enterprises with the lowest weighted capital average cost makes the supply chain operating at different capital costs generate higher profits. HC Pfohl, M Gomm determines the



mathematical model of supply chain finance from the perspective of capital cost rate based on the cost of capital and the cost of capital, and clarifies how to apply different refinancing rates in the supply chain to reduce the overall Financing costs, while pointing out that information within the supply chain can be used to reduce investment risk and the cost of capital for financing projects within the supply chain. Berling and Rosling point out that financial risk has an impact on supply chain strategies. Viktoriya Sadlovska examined the contribution of supply chain finance to the improvement of cash flow, and examined it from two aspects: capital turnover and collection of accounts receivable.

3. Notation and assumptions

Assumption 1. The online block chain platform, and the supplier are all riskneutral, and they maximize their expected profits.

Assumption 2. The suppliers have difficulty in obtaining bank loans and therefore the block chain platform is the only financing option available.

Assumption 3. The bank don't interrupt the financing activity.

Assumption 4. The capital market is perfect without taxes, operation costs, and bankruptcy costs, and therefore we omit these costs in the paper .

Assumption 5. The deserve financing not left in the end.

Assumption 6. The platform adjust the rate to finance the supply chain.

Sheet1. Notation

A_i	The profit of supplier get from supply chain financing	B_i	The profit of the third logistic
s	The loan amount of Block chain platform service to the supplier	p_i	Supplier default rate
I_D	Internet financing interest rate for the suppliers	I_i	Block chain platform service rate provided to the suppliers
D_{ai}	Guarantee fee	f_i	Loan fee
I_{ij}	Block chain platform service rate provided to the supplier A's supplier supplier B	I_i	Block chain platform service rate provided to the suppliers

4. Optimal strategies for financing a supply chain based on blockchain platform

Proposition 4.1 When

$$p_i < \frac{sI_i + f_i - sI_D}{sI_i - D_{ai} + s},$$

Blockchain platform can obtain profit, they will service for the supply chain.

Proof:

	Success	Default
Loan	$X_i - sI_i - f_i$	$X_i + s - D_{ai} - f_i$
Not loan	0	0

Since $A_{i \text{ not loan}} < A_{i \text{ loan}}$, we can get $p_i < \frac{sI_i + f_i - sI_D}{sI_i - D_{ai} + s}$.

Proposition 4.2 In this modle, the Block chain platform service rate provided to the suppliers

increasing by the supplier default rate.

Proof:

If $A_{i \text{ not loan}} = A_{i \text{ loan}}$

$$(1-p_i)(sI_i + f_i - sI_D) + p_i(D_{ai} + f_i - s(I_D + 1)) = 0$$

Suppose it is perfect competitive market, the marginal Block chain platform service rate provided to the suppliers

$$I_i = \frac{p_i(s - D_{ai}) + sI_D - f_i}{s(1-p_i)}$$

First order derivation based on p_i

$$\frac{dI_i}{dp_i} = \frac{s(1+I_D) - (D_{ai} + f_i)}{(1-p_i)^2 s^2}$$

when $A_{i \text{ loan}} = A_{i \text{ not loan}}$,

$$p_i = \frac{sI_i + f_i - sI_D}{sI_i - D_{ai} + s}$$

For $0 < p_i < 1$, we can get $s + sI_D > f_i + D_{ai}$, obviously $1 - p_i > 0$, so $\frac{dI_i}{dp_i} > 0$,

So we can get the Block chain platform service rate provided to the suppliers increasing by the supplier default rate.

Proposition 4.3 For supplier, the scale of loan increase with the loan rate increasing. When $0 < I_i < \frac{P_i}{1 - P_i}$, the guarantee fee will increase with the scale of loan increasing; When

$I_i > \frac{P_i}{1 - P_i}$, the guarantee fee will decrease with the scale of loan increasing.

Proof : Supplier obtain the loan to guarantee getting the maximum profit.

$$A_{i \text{ load}} = X_i + p_i(s - D_{ai}) - f_i - (1 - p_i)sI_i \quad (4.6)$$

$$A_{i \text{ not load}} = 0$$

when $A_{i \text{ loan}} = A_{i \text{ not loan}}$,

$$I_i = \frac{X_i + p_i(s - D_{ai}) - f_i}{(1 - p_i)s}$$

$$D_{ai} = \frac{X_i + p_i s - f_i - (1 - p_i)sI_i}{p_i}$$

I_i First order derivation based on s

$$\frac{dI_i}{ds} = \frac{p_i(X_i + s - D_{ai} + f_i)}{(1 - p_i)^2 s^2}$$

For $0 < P_i < 1$, $X_i + s > D_{ai} + f_i$, so we can get $\frac{dI_i}{ds} > 0$

To avoid risks, the Block chain platform service rate provided to the suppliers increasing by the loan amount of Block chain platform service to the supplier.

D_{ai} First order derivation based on s

$$\frac{dD_{ai}}{ds} = \frac{p_i - (1 - p_i)I_i}{p_i}$$

$$\text{If } \frac{dD_{ai}}{ds} = 0, I_i = \frac{(1 - p_i)}{p_i}.$$

When $0 < I_i < \frac{p_i}{1 - p_i}$, the Guarantee fee is increasing by the loan amount of block chain platform

service to the supplier.

5. Conclusion:

We looked at a SCF system consisting of a manufacturer, an online blockchain financing platform and a capital-constrained provider. The optimal Stackelberg decision - making problem in SCF system is analyzed. Specifically, we consider two different scenarios :(1) SCF systems with blockchain online financing platforms; (2) SCF system with normal platform. Our analysis shows that in both cases, the optimal strategy is completely different.

For the SCF system of suppliers with financial constraints, we find that with the increase of the supplier's loan balance and the supplier default rate, the optimal service rate of the blockchain platform provided to the supplier increases accordingly. This is because higher service rates or higher Internet financing rates mean higher financing costs, resulting in smaller loan amounts.

References

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