

Current Status and Risk Evaluation of Supply Chain Finance Business in Commercial Banks

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Abstract

Supply chain finance has become a new type of financing model provided by commercial banks. This paper first analyzes the development status of the supply chain finance business in commercial banks. In the analysis of the risk management on the supply chain finance in commercial banks, this paper applies the group decision theory and the triangular fuzzy number in the risk evaluation and proposes a fuzzy group decision-making evaluation model to measure the supply chain finance business in commercial banks based thereon, and then uses an example to test the applicability of the model. At last, this paper puts forward suggestions on risk management.

Keywords: supply chain finance, risk evaluation, triangular fuzzy number, group decision theory, risk management

1. INTRODUCTION

The supply chain finance, in the modern sense, originated in the 1980s. It was an innovative business developed by commercial banks based on enterprise supply chain management (Geunes and Pardalos, 2003; Cruz et al., 2006). However, as an innovative financial product, supply chain finance also inevitably encounters a number of risks and problems in its development process (Gupta and Dutta, 2011), so how to carry out effective risk management (Wagner et al., 2012; Yu et al., 2013) to ensure the stability and safety of supply chain finance has become an issue that should be considered in the further development of the supply chain finance by commercial banks.

Many scholars have analyzed the concept and contents of supply chain finance from different perspectives and studied the risk management on supply chain finance (Guillén et al., 2007; Dehning et al., 2007; Blome and Schoenherr, 2011; Marquez et al., 2004). This paper starts from the current development of the supply chain finance business in commercial banks and studies the risk management by carrying out risk evaluation on the supply chain finance in commercial banks in the hope of providing useful reference for the risk management on supply chain finance in commercial banks.

2. CURRENT STATUS OF SUPPLY CHAIN FINANCE BUSINESS IN COMMERCIAL BANKS

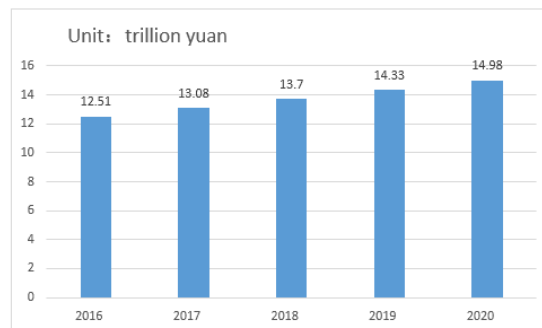
2.1. Development history and current status of bank supply chain finance

Shenzhen Development Bank (now known as Ping An Bank) was the first to develop the first develop the supply chain finance business. In 2001, it first launched chattel and goods right pledge credit business (hereinafter referred to as “inventory financing business”); in 2003, it launched the “1 + N” supply chain financing service, which has become the biggest feature of Shenzhen Development Bank and also a milestone in the development of supply chain finance in China and laid a solid foundation for the subsequent self-liquidation trade financing credit system (Elgazzar et al., 2012). In 2006, the “supply chain finance” brand was officially introduced in the domestic banking industry (Wuttke et al., 2013). In 2012, supply chain finance 2.0 product series were officially launched (Jr et al., 2010). At present, other domestic commercial banks are actively developing supply chain finance business, and details of the development are listed in Table 1.

Table 1 The development of supply chain financial business of several commercial banks

Commercial bank	Financial product and service	Characteristics
Bank of China	Rong Fu Da Post Finance; Rong Yi Da; Rong Huo Da; Tong Yi Da	Trade financing, guarantee policy guarantee and other business with China export credit insurance company or other authorized credit insurance institution
China Construction Bank	Network Bank "e loans" series of products	Including accounts receivable financing and inventory pledge financing
Industrial bank Co.Ltd	Gold sesame seeds, gold cube	Targeted to provide venture capital, temporary shortage, low-cost procurement, rapid return program and other one-stop service; online financial management, efficient billing
China Merchants Bank	Car dealer financing, forensic lending and forensic commitment	Provide a specific financing scheme, a variety of varieties, high selectivity.
China Everbright Bank	1 + N factoring financial services business	Integrated financial services including trade finance, accounts receivable management and account receivable.
Bank of Communications	Yuntong wealth	Featured products and services, according to the problems encountered or needs to provide dealer services, supply
Industrial and Commercial Bank of China	Supply chain finance, Yi Rong Tong, online commodity trading market financing	Quality customer or core customer supplier based on supply chain accounts receivable through the supply chain service platform and the bank's financing business occurred
China Minsheng Bank	Industry chain finance	Contains sixteen value added chain

According to the estimates by relevant agencies, at present, the accounts receivable of the enterprises in China has reached a scale of RMB 20 trillion Yuan. If these accounts receivable are used as potential collaterals for bank loans, the supply chain finance market in China will have a broad prospect for development (Longinidis and Georgiadis, 2011; Zeballos et al., 2012). According to the supply chain industry report by Forward Industry Research Institute, by 2020, the supply chain finance market in China will expand to a size of RMB 14.98 trillion Yuan.

**Figure 1** Prediction of Supply Chain Finance Market Size in China (2016-2020)

2.2 Financing Models of Supply Chain Finance

The supply chain finance business is designed mainly for small-sized and medium enterprises (SMEs). It can be divided into three models - accounts receivable financing model (Liu and Cruz, 2012), Advance financing model (Longinidis and Georgiadis, 2013) and inventory financing model.

(1) Accounts receivable financing model. Accounts receivable financing refers to the act of borrowing from a commercial bank with the accounts receivable that have not yet been received (Ramezani et al., 2014). The specific flow chart is shown in Fig. 2.

In Fig. 2, 1)an SME signs a commodity sales contract withthe core enterprise and delivers goods to the core enterprise; 2)the SME receives the accounts receivable document; 3) the SME submits the accounts receivable document to the commercial bank as pledge; 4)the core enterprise makes payment commitment to the commercial bank; 5)the commercial bank grants a loan to the SME; 6)the core enterprise sells goods and receives the payment; 7) the core enterprise pays the amount of the accounts receivable to the designated account.

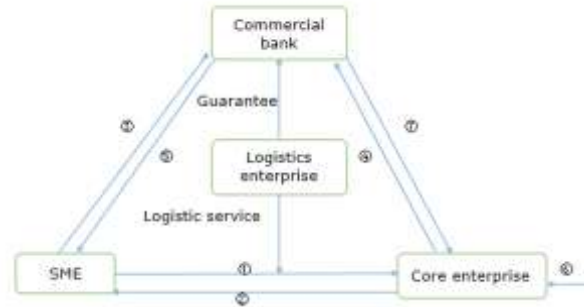


Figure 2 Flow chart of the Accounts Receivable Financing Model

In this financing model, the commercial bank is more concerned about the repayment ability of the SME and the transaction risks. In this model, the core enterprise assumes the debt, but due to its good credit and ability, it can provide counter-guarantee for the SME. If the SME cannot repay the loan due to any reason, the core enterprise will be obliged to repay the loan. In this way, the commercial bank can effectively reduce its risks.

(2) Advance financing model. Advance financing is a kind of financing model in which the buyer pays a certain amount of deposit to the commercial bank as the credit grantor and the commercial bank grants an loan to the buyer by making payment to the seller and taking the goods as the collateral (Xu et al.,2015). The specific process is shown in Fig. 3.

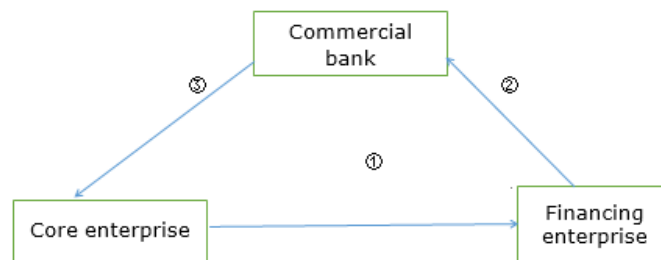


Figure 3 Flow chart of Advance Financing Mode

In Fig. 3, 1) the core enterprise delivers the goods to the financing enterprise; 2) the financing enterprise provides the accounts payable to the commercial bank; 3) the commercial bank pays the advance to the core enterprise.

(3) Inventory financing model. Inventory financing is a financial model in which the borrower obtains funds to support its production and sales activities by using the value of its current assets including inventory as the financing guarantee. As the inventory financing can be operated independent of the core enterprise, usually it is used as the transitional product for advance payment.

3. RISK MANAGEMENT ON SUPPLY CHAIN FINANCE BUSINESS IN COMMERCIAL BANKS

3.1 Risk evaluation on supply chain finance in commercial banks

(1) Risk evaluation index system for supply chain finance business in commercial banks

In the evaluation on the risks of supply chain finance business, it is necessary to establish a reasonable index system first. Based on the above analysis and associated literatures, the evaluation index system established in this paper consists of five parts—the operational risks of the commercial bank, the supervision risks of the logistic enterprise, the credit risks of the fund raiser, the risks of the pledge, and the supply chain operational risks. Details are shown in Table 2.

Usually, when estimating and rating the evaluation system indexes, the evaluators tend to use fuzzy words like “good” or “average”. Therefore, this paper introduces the triangular fuzzy number to perform a quantitative analysis of the linguistic evaluation.

Table 2 Risk Evaluation Index System for Supply Chain FinanceBusiness in Commercial Banks

Five indicators	Indicators refinement
Operational risks of the commercial bank(U_1)	Business experience accumulation Professional training Information systems and technical support
Supervision risks of the logistic enterprise(U_2)	Qualification and credit Safety management system Safety management facilities and tools
Credit risks of the fund raiser (U_3)	financial status Status of reputation Growth potential
Pledge risks(U_4)	Huoquan risk Liquidity risk Stability of market price Insurance or not
Supply chain operational risks (U_5)	Status of core enterprises Industrial conditions Cooperation degree of supply chain

(2) Basic knowledge of triangular fuzzy number

The triangular fuzzy number is used to solve issues under an uncertain environment. The concept of Dev fuzzy set, proposed by Zadeh in 1965, is mainly applied in risk management.

Definition 1: triangular fuzzy number: denote all fuzzy sets of R as $F(R)$. Let $\hat{M} \in F(R)$. If the membership function

of $\hat{M}$ is $\mu_{\hat{M}}$, and $R \rightarrow [0,1]$, then $\mu_{\hat{M}} = \begin{cases} \frac{x-l}{m-l}, & x \in [l, m] \\ \frac{x-u}{m-u}, & x \in [m, u] \\ 0, & x \notin [l, u] \end{cases}$. In the formula, $l \leq m \leq u$, l and u are the lower bound

and upper bound of $\hat{M}$, m is the mid value of $\hat{M}$ and $\hat{M}$ is the triangular fuzzy number. Usually, the triangular fuzzy number can be denoted as $\hat{M}(l, m, u)$. Let $\delta = u - l$. The greater δ is, the higher the fuzziness will be; the smaller δ is, the lower the fuzziness will be. If $\delta = 0$, it means the result is non-fuzzy. For any two positive triangular fuzzy numbers $\hat{M}_1(l_1, m_1, u_1)$ and $\hat{M}_2(l_2, m_2, u_2)$, the general algorithms include the followings:

- 1) $\widehat{M}_1 + \widehat{M}_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$
- 2) $\widehat{M}_1 - \widehat{M}_2 = (l_1 - l_2, m_1 - m_2, u_1 - u_2)$
- 3) $k\widehat{M}_1 = (kl_1, km_1, ku_1)$
- 4) $\widehat{M}_1/\widehat{M}_2 = (l_1/u_2, m_1/m_2, u_1/l_2)$
- 5) $(l, m, n)^{-1} = (1/u, 1/m, 1/l)$

The probability of $\widehat{M}_1 \geq \widehat{M}_2$ is defined as:

$$V(\widehat{M}_1 \geq \widehat{M}_2) = \begin{cases} 1, m_1 \geq m_2 \\ \frac{l_2 - u_1}{(m_1 - u_1) - (m_2 - l_2)}, (m_1 < m_2, l_2 \leq u_1) \\ 0, \text{others} \end{cases} \quad (1)$$

Definition 2: calculation of the value quantity of the fuzzy number: translate the fuzzy number to a certain non-fuzzy value quantity. The detailed process is as follows: let the trapezoidal fuzzy number $\tilde{F}(u) = (a, b, c, d)$, and the value quantity of the non-fuzzy number is h , denoted as $D(\tilde{F})$, so

$$h = D(\tilde{F}) = [a + b + c + d]/4 \quad (2)$$

For the triangular fuzzy number $\widehat{M} = (l, m, u)$, and the membership function is $\mu_{\widehat{M}}$, then the λ mean area of the triangular fuzzy number $\widehat{M} = (l, m, u)$ - $s_{\lambda}(\widehat{M}) = [\lambda l + m + (1 - \lambda)u]/2$, which is the value quantity of this triangular fuzzy number. In the equation, $\lambda \in [0, 1]$, showing the decisionmaker's aversion to risks. If $\lambda = 0$, it means the decision maker is not risk-averse, i.e. he/she is adventurous; if $\lambda = 0.5$, it means that the decision maker does not care the risks, i.e. he/she is neutral; if $\lambda = 1$, it means that the decision maker is risk-averse, i.e. he/she is conservative. When calculating the value quantity of the triangular fuzzy number, usually we take $\lambda = 0.5$, so

$$s(\widehat{M}) = (l + 2m + u)/4 \quad (3)$$

(3) Triangular fuzzy set method and computation process

The first step is to determine the weight vector of the primary index, which is expressed by the fuzzy number translated from the linguistic evaluation on the importance of the primary index $U_t (t = 1, 2, \dots, n)$ in the evaluation system given by evaluators $e_i (i = 1, 2, \dots, l)$ from the commercial bank and the logistic enterprise responsible for supervision. The translation rule used in this paper is shown in Table 3. In specific cases, there may be multiple translation rules for the triangular fuzzy number based on actual conditions.

By aggregating the weights given by each evaluator using the average operator, we can obtain the fuzzy weight of each primary index:

$$\widehat{k}_t = \left(\frac{1}{l}\right) \otimes (\widehat{k}_{t1} \oplus \widehat{k}_{t2} \oplus \dots \oplus \widehat{k}_{tl}) = \frac{1}{l} (\sum_{i=1}^l \widehat{k}_{ti}) = (d_t, e_t, f_t) \quad (4)$$

Where, $\widehat{k}_{ti}$ stands for the fuzzy weight of each primary index U_t assigned by the evaluator e_i .

Using Formula (3), we can translate the fuzzy weight of each primary index into the corresponding non-fuzzy number:

$$s(\widehat{k}_t) = (d_t + 2e_t + f_t)/4 \quad (5)$$

Then we use the following formula to process the weight $s(\hat{k}_t)$:

$$k_t = s(\hat{k}_t) / \sum_{t=1}^n s(\hat{k}_t) \quad (6)$$

Then we can obtain the weight vector of the primary index described by specific data - $k = (k_1, k_2, \dots, k_n)$.

Table 3 Translation Table for Linguistic Evaluation and Corresponding Triangular Fuzzy Numbers

Linguistic evaluation of weight	Linguistic evaluation of evaluation value	Corresponding triangular fuzzy number
Absolutely essential	excellent	(0.9, 1.0, 1.0)
Very important	Very good	(0.7, 0.9, 1.0)
important	good	(0.5, 0.7, 0.9)
Of average importance	fair	(0.3, 0.5, 0.7)
Of little importance	Slightly poor	(0.1, 0.3, 0.5)
Not important	poor	(0, 0.1, 0.3)
Not important at all	Very poor	(0, 0, 0.1)

Step 2 is to determine the matrix for the rating numbers of all businesses under evaluation

Each evaluator $e_i (i = 1, 2, \dots, l)$ gives linguistic evaluation on each primary index U_t in m projects $p_j (j = 1, 2, \dots, m)$, which is translated to a triangular fuzzy number one by one. The fuzzy integration method for the ratings of all businesses under valuation is as follows:

$$\hat{q}_{tj} = \left(\frac{1}{l}\right) \otimes (\hat{q}_{tj1} \oplus \hat{q}_{tj2} \oplus \dots \oplus \hat{q}_{tjn}) = \frac{1}{l} (\sum_{i=1}^l \hat{q}_{tji}) = (a_{tj}, b_{tj}, c_{tj}) \quad (7)$$

Where, $\hat{q}_{tj}$ represents the geometric average fuzzy rating number of each business p_j under the primary index U_t ; $\hat{q}_{tji}$ represents the rating number of each business p_j under each primary index U_t by each evaluator e_i .

According to Formula (5), we translate the triangular fuzzy number of each rating number into the corresponding non-fuzzy number:

$$s(\hat{q}_{tj}) = [a_{tj} + 2b_{tj} + c_{tj}] / 4 \quad (8)$$

From this, we can obtain the evaluation matrix described by specific data.

$$q_{ij} = [s(\hat{q}_{ij})]_{m \times n} \quad (9)$$

In Step 3, we perform overall evaluation on each business under evaluation and sort them using the following calculation formula:

$$\varpi_j = q_{ij} \times k^T = [s(\hat{q}_{ij})]_{m \times n} \times (k_1, k_2, \dots, k_n)^T = (\varpi_1, \varpi_2, \dots, \varpi_m)^T \quad (10)$$

We sort $\varpi_1, \varpi_2, \dots, \varpi_m$ by size. The larger the ϖ_j is, the lower risk the p_j will have. We can also set a risk alert control point. If ϖ_j is above the control point, p_j should be a low-risk business; otherwise it should be a high-risk one.

3.2 Case Analysis

We take one commercial bank for example. The 3 supply chain finance businesses it has entered into with different logistic enterprises are guaranteed by the core enterprise in the industry. The pledges are aluminum pig, wooden furniture and cell phones. We invite 4 evaluators (e_1, e_2, e_3, e_4) to perform risk evaluation on these three projects.

The weights of the indexes and the linguistic evaluation on these projects given by the evaluators are listed in Table 4 and 5.

Table 4 Linguistic evaluation of weight

	U_1	U_2	U_3	U_4	U_5
e_1	Not important	important	Absolutely essential	Very important	important
e_2	Not important at all	Of average importance	Very important	important	Of average importance
e_3	Not important	important	Very important	Of average importance	Of average importance
e_4	Of little importance	Of average importance	Absolutely essential	important	Of little importance

Table 5 Each project corresponding to each index factor value of language

		U_1	U_2	U_3	U_4	U_5
P_1	e_1	fair	Slightly poor	fair	excellent	poor
	e_2	poor	good	fair	Very good	Slightly poor
	e_3	Slightly poor	fair	Slightly poor	good	fair
	e_4	Very poor	fair	fair	Very good	fair
P_2	e_1	Very good	fair	Very good	poor	Slightly poor
	e_2	good	good	fair	fair	good
	e_3	excellent	fair	fair	Slightly poor	fair
	e_4	good	good	good	fair	fair
P_3	e_1	Very good	fair	good	fair	good
	e_2	fair	good	excellent	Very good	fair
	e_3	fair	Very good	Very good	good	fair
	e_4	good	good	Very good	fair	good

By reference to Table 3, we translate the linguistic evaluation given by the 4 evaluators to triangular fuzzy numbers and calculate the primary index weight vectors using Formula (4)-(6), as shown in Table 6. Then we calculate the corresponding value matrix for the primary index of each business, as shown in Table 7.

Table 6 Weight vector of each primary evaluation index

	U_1	U_2	U_3	U_4	U_5
$s(\bar{k}_t)$	0.14452	0.6011	0.9198	0.69402	0.4998
k_t	0.05019	0.2101	0.3228	0.24239	0.1752

Table 7 Each evaluation index of business class corresponding value matrix

Pending business	U_1	U_2	U_3	U_4	U_5
P_1	0.2369	0.5011	0.4499	0.8559	0.3564
P_2	0.8132	0.6012	0.6442	0.3564	0.4999
P_3	0.6442	0.6942	0.8559	0.6440	0.6012

According to Formula (10), we obtain the overall rating of the business. By integrating q_{tj} and k_t , we obtain the overall rating of each project under evaluation $\varpi_j = (0.53193, 0.548276, 0.715287)$. We can clearly see that $\varpi_3 > \varpi_2 > \varpi_1$, so the final business risk ranking is $p_1 > p_2 > p_3$. The best business is p_3 , whose risk is the lowest; the businesses p_1 and p_2 have similar risks, which are relatively high. If the required risk alert control point is 0.70, then the business p_3 is low-risk and businesses p_1 and p_2 are high-risk.

4. RISK MANAGEMENT MEASURES FOR SUPPLY CHAIN FINANCE IN COMMERCIAL BANKS

4.1. Carefully choose the core enterprise

A bank should carefully choose a core enterprise and assess its line of credit by taking into account the status of the core enterprise in the industry, current status of the industry, industry type, sales scale, business development needs, credit status, credit records and line of credit in various banks.

4.2. Establish strict approval systems

After completing the detailed supply chain approval procedures, the bank should carry out evaluation on the specific credit receiver. At the same time, the credit granting rating system should also be set up for each supply chain finance business, i.e. accounts receivable financing, advance financing and inventory financing.

4.3. Establish a risk early-warning mechanism

Abnormal conditions of collaterals/pledges are also an important part of the early warning for supply chain finance business. Since the collaterals/pledges in the supply chain finance business are in different forms and of different values and concern the penalty cost of the credit receiver and the guarantee for the creditor's right of the bank, commercial banks should pay special attention to this part.

5. CONCLUSIONS

Conclusions of this paper are as follows:

(1) At present, many commercial banks in China are actively developing supply chain finance business, and have achieved certain results; at the same time, supply chain finance in commercial banks in China are developing very fast, with a very broad prospect.

(2) We establish a risk evaluation index system for commercial banks, which consists of five parts—the operational risks of the commercial bank, the supervision risks of the logistic enterprise, the credit risks of the fund raiser, the risks of the pledge, and the supply chain operational risks. In this paper, we apply the group decision theory and the triangular fuzzy number in the risk evaluation and proposes a fuzzy group decision-making evaluation model to measure the supply chain finance business in commercial banks based thereon, and then we use an example to test the applicability of the model.

(3) In order to effectively mitigate or reduce commercial banks' risks in supply chain finance, commercial banks should carefully choose the core enterprise during the risk management and establish strict approval systems and effective risk early-warning mechanisms in a timely manner.

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