

Selection model and n -tier expansion of collaborative credit-granting guaranty mechanisms and techniques grounded on agile virtual enterprise*

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Abstract. Collaborative credit granting is a key link in the operation of Agile Virtual Enterprise (AVE) chain and its supply chain. This paper first analyzes the measurement model of modern credit risk, and then it proposes the selection model of collaborative credit-granting guaranty techniques grounded on capital property pricing, and some important conclusions are further reached on the basis of the empirical studies. Meanwhile, n -tier expansion is constructed for the collaborative credit-granting monitoring mechanism grounded on AVE. Under this mechanism, the credit risk in the AVE enterprises can be optimized; and the AVE chain matches the working mechanisms in their capacities of real-time resource sharing, n -tier resource allocation, mission assignment, control and supervision. In the end, the distance management and risk blockage could be accomplished on the supply chains in all the AVE enterprises by forming a strong self-organized and self-control working chain, and the research orientation is indicated by integrating this mechanism with AVE-based Collaborative Planning, Forecasting and Replenishment (CPFR) working system.

Keywords: credit-granting guaranty, credit risk, n -tier monitor, AVE, CPFR

1 Introduction

As economic globalization increases, life cycles of products shorten and market fluctuations become intense, Agile Virtual Enterprise (AVE) members confront the challenge of higher credit risk^[7, 13]. Research shows that inadequate measurement of credit risk is the major factor contributing to bankruptcy of banks and enterprises. Regarding the working mechanism of AVE-based Collaborative Planning, Forecasting and Replenishment (CPFR)^[9], high credit risk can disrupt the overall AVE chains and supply chains and it can even destroy enterprises on the chain. Collaborative credit granting grounded on AVE is a key link in the operation of AVE chains. It can be deployed to improve the overall production and operation efficiency of AVE members on the chain substantially. Nevertheless, it is also a primary factor contributing to higher credit risk for AVE collaboration.

Credit risk is also known as default risk, which refers to the possibility of suffering the loss by banks, investors or other transacting parties, because borrowers, bond issuers or traders are not willing to or are not able to meet their contractual obligations and default for one reason or another. In the context of the credit risk measurement, "New Basel Capital Agreement" recommends the Inner-ratings-based approach (IRB) composed of two editions: Foundation IRB approach and Advanced IRB approach^[14, 15]. IRB proposed four major parameters: Probability of Default (PD), Loss of Given Default (LGD), Exposure at Default (EAD) and Maturity (M).

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Foundation IRB approach has simple requirements and calculation of PD alone is necessary. Others are based on the relevant indices, and it is easy to implement. On the other hand, Advanced IRB approach is relatively complicated, and it calls for calculation of the above four parameters individually. After the major parameters are confirmed, Expected Loss (EL), Unexpected Loss (UL) and Economic Capital (EC) can be calculated.

The measurement model of credit risk has undergone a development process. Initially, the Credit Monitor Model was proposed by KMV Company in 1993 on the basis of the BSM Model^[10]. Credit Metrics was later developed by JP Morgan Bank and KMV Company in 1997 by using a two-phase approach^[11, 12]. Mortality Model was developed by Edward I. Altman, Suggitt, and Kishore pertaining to bond margins and accumulated mortality^[1-3]. CreditRisk+ Model was developed by the First Boston Bank (Switzerland); it originated from the concept of the insurance calculation in 1997^[16]. Credit Portfolio View was proposed by Saunders and Wilson^[5, 18]. They deployed the principles of foundation dynamics and analyzed the credit rate transference of the borrowers in the context of macroeconomics. This is also known as the McKinsey Model. Loan Analysis System (LAS) was proposed by Belkin, Crouhy and Mark on the basis of the Risk Neutralization Theory^[4, 6]. Delianedias and Geske further developed the model by deploying the Maturity Pricing Model, shifting the expected profits of corporate capital value into risk-free interest rate, and treating the face value of the loan as default implementation^[8].

Different measurement models of credit risk provide quite different results pertaining to the expected effect. The advanced credit risk measurement approach assumes that interest rate is a random process and can deal with maturity and exchange and other derivative products, but other models have assumptions to refute stability of interest rate and risk exposure, in addition to suggesting that they fail to deal with non-linear derivative products very well. These measurement models of credit risk have not taken the following factors into consideration: the credit granting of borrowers, credit transference rate, guaranty competence, debt term, morality risk, national policy and economic cycles and the like. The measurement model of credit risk is employed to calculate the loan portfolio, and it fails to meet the requirements of the Advanced IRB approach.

2 Selection model of collaborative credit-granting techniques based on capital assets pricing

Capital Assets Pricing Model (CAPM) is concerned with the theory of capital market, and it can be seen as a positive and a balanced model in general^[17]. It offers definite conclusions for effective investments by providing reasonable prices for all the assets in the capital markets. Capital Market Theory (CMT) and Stock Market Line (SML) are two major components of the Capital Market Theory.

Business credit granting and commercial bank loans share some homogeneity-that is, they both seek to gain profits under the assumption of obtaining the return safely. The commercial bank loan obtains profits from interest. Profits of business credit granting are embodied in the credit-granting charges - i.e. the money paid by the credit-granted enterprises to the credit-granting agencies. The capacity of credit-granted enterprises to pay interest in terms of the loan contract and to return the loan at maturity are important criteria for the credit-granting enterprises to evaluate the position of the credit-granted enterprises. However, credit-granting businesses do not regard the criteria as the only factor for evaluation in real operations. Meanwhile, they also take into account product absorbing capacity and sales channels of the credit-granted enterprises. With regard to the credit-granting guaranty, different interest rates after credit-granting default can be seen as the safety valve for returning the loan or the profit sources at loan default.

Hypothesis 1: With regard to the notion of credit risk, the loan from credit-granting enterprises to credit-granted enterprises calls for returning in light of the loan contract, after the promised duration. It can be understood as the foundation to decide whether the credit-granted enterprises need credit guaranty.

Hypothesis 2: Corporate and guaranty assets are subject to normal distribution. Corporate assets are $C \sim N(\mu_1, \delta_1^2)$, and the guaranty assets are $G \sim N(\mu_2, \delta_2^2)$, in which μ_1 and μ_2 are more than 0, and C and G are irrelevant.

Hypothesis 3: The credit-granting amount is b (in terms of Hypothesis 1, the interest returned after maturity is $b(1 + r)$, in which r is the loan interest rate). Under this hypothesis, the functions of guaranty in reducing risk are analyzed, given that C and G are irrelevant. Therefore distribution of the overall assets value $Y = C + G \sim N(\mu_1 + \mu_2, \delta_1^2 + \delta_2^2)$ can be calculated under guaranty conditions.

Hypothesis 4: Random variables C and G share the same relevant coefficients in the market, regardless of the transaction cost.

Hypothesis 5: Commercial profits of credit-granting enterprises are embodied in the credit granted. The profit rate can be zero or 100%, and it can be neglected due to the big gap.

Hypothesis 6: Effect of inflation is neglected.

In light of the theory of risk and income equity, credit granting with and without guaranty can be considered as risk assets in two different channels of loans. They have the same relevant coefficients in the market. Therefore, the relationship between profitability and the risk rate can be established, and subsequently it may be decided whether it is overestimated or underestimated. Relatively attractive 'assets' can be identified by quantitative calculation - that is, which credit-granting approach is more effective? Considering the notion of maturity, only if the business assets value is less than its debt, it will opt for breaching the contract. As a result, in the course of constructing this model, the gap between the value of the business assets and credit-granting interest is always under consideration. This is deployed to predict the possible loss and profits of the risk assets.

2.1 Risk yield without guaranteed credit granting

In the context of credit granting without guaranty, given that the interest rate is r_n , the expected yield is R_n , and the granted credit is b , the enterprises return and pay the interest rate for $b(1+r_n)$ on maturity beyond the promised duration.

The formula for the expected yield without guaranteed credit granting is illustrated as follows:

$$E(R_n) = - \int_{-\infty}^0 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx + \int_0^{b(1+r_n)} \left(\frac{x-b}{b}\right) \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx \\ + r_n \int_{b(1+r_n)}^{\infty} \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx$$

When the corporate assets are $C > b(1+r_n)$, the assets yield is R_n , and the probability is

$$\int_{b(1+r_n)}^{\infty} \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx.$$

When the corporate assets are $0 \leq C \leq b(1+r_n)$, the assets yield is $\frac{c-b}{b}$, and the probability is

$$\int_0^{b(1+r_n)} \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx.$$

When the corporate assets are $C \leq 0$, the yield is -1 , and the probability is

$$\int_{-\infty}^0 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx.$$

Thereby, the expected yield is:

$$E(R_n) = - \int_{-\infty}^0 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx + \int_0^{b(1+r_n)} \left(\frac{x-b}{b}\right) \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx \\ + r_n \int_{b(1+r_n)}^{\infty} \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx$$

This can be illustrated in the standard form as follows:

$$E(R_n) = -\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \frac{1}{\sqrt{2\pi}b} \left[\delta_1 E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} \Big|_0^{b(1+r_n)} \right] + \frac{\mu_1}{b} \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \phi\left(\frac{-\mu_1}{\delta_1}\right) \right] + r_n \left[1 - \phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) \right] \quad (1)$$

The yield square difference is:

$$D(R_n) = \int_{-\infty}^0 (-1-R_n)^2 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx + \int_0^{b(1+r_n)} \left(\frac{x-b}{b} - R_n\right)^2 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx + \int_{b(1+r_n)}^{\infty} (r_n - R_n)^2 \frac{1}{\sqrt{2\pi}\delta_1} E^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} dx$$

This can be represented in the standard form as follows:

$$D(R_n) = (1+R_n)^2 \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) \right] + (r_n - R_n)^2 \left[1 - \phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) \right] - \frac{2\mu_1(1+R_n)}{b} \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \phi\left(\frac{-\mu_1}{\delta_1}\right) \right] + \frac{2\delta_1(1+R_n)}{\sqrt{2\pi}b} \left(e^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} \Big|_0^{b(1+r_n)} \right) - \frac{\delta_1}{\sqrt{2\pi}b^2} \left(e^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} (x-\mu_1) \Big|_0^{b(1+r_n)} \right) + \frac{\delta_1^2}{b^2} \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \phi\left(\frac{-\mu_1}{\delta_1}\right) \right] - \frac{\mu_1^2}{b^2} \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \phi\left(\frac{-\mu_1}{\delta_1}\right) \right] + \frac{2\mu_1^2}{b^2} \left[\phi\left(\frac{b(1+r_n)-\mu_1}{\delta_1}\right) - \phi\left(\frac{-\mu_1}{\delta_1}\right) \right] - \frac{2\mu_1\delta_1}{\sqrt{2\pi}b^2} \left(e^{-\frac{(x-\mu_1)^2}{2\delta_1^2}} \Big|_0^{b(1+r_n)} \right) \quad (2)$$

2.2 Risk yield with guaranteed credit granting

Under guaranty conditions, given that the interest rate is r_y , and the expected yield is R_y , and the granted credit is , the enterprises return and pay the interest rate for $b(1+r_n)$ on maturity beyond the promised duration. The formula of the expected yield with guaranteed credit granting is presented as follows:

When the corporate assets are $Y \geq b(1+r_y)$, the assets yield is r_y , and the probability is

$$\int_{b(1+r_y)}^{\infty} \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx.$$

When the corporate assets are $0 \leq Y \leq b(1+r_y)$, the assets yield is $\frac{Y-b}{b}$, and the probability is

$$\int_0^{b(1+r_y)} \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx.$$

When the corporate assets are $Y \leq 0$, and the assets yield is -1 , the probability is

$$\int_{-\infty}^0 \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx.$$

Thereby, there are:

$$E(R_y) = \int_{b(1+r_y)}^{\infty} r_y \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx + \int_0^{b(1+r_y)} \frac{x-b}{b} \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx - \int_{-\infty}^0 \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx$$

This can be illustrated in the standard form as follows:

$$\begin{aligned}
 E(R_y) = & -\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \frac{\sqrt{\delta_1^2 + \delta_2^2}}{\sqrt{2\pi}b} \left(E\left.\frac{-(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}\right|_0^{b(1+r_y)} \right) \\
 & + \frac{\mu_1 + \mu_2}{b} \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \phi\left(\frac{-\mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & + r_y \left[1 - \phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right]
 \end{aligned} \tag{3}$$

The yield square difference is:

$$\begin{aligned}
 D(R_y) = & \int_{-\infty}^0 (-1 - R_y)^2 \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx \\
 & + \int_{b(1+r_y)}^{\infty} (r_y - R_y)^2 \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx \\
 & + \int_0^{b(1+r_y)} \left(\frac{x-b}{b} - R_y\right)^2 \frac{1}{\sqrt{2\pi} \sqrt{\delta_1^2 + \delta_2^2}} E^{-\frac{(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}} dx
 \end{aligned}$$

This can be illustrated in the standard normal distribution as follows:

$$\begin{aligned}
 D(R_y) = & (1 + R_y)^2 \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] + (r_y - R_y)^2 \left[1 - \phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & - \frac{2(\mu_1 + \mu_2)(1 + R_y)}{\sqrt{2\pi}b} \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \phi\left(\frac{\mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & + \frac{2\sqrt{\delta_1^2 + \delta_2^2}(1 + R_y)}{\sqrt{2\pi}b} \left(e\left.\frac{-(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}\right|_0^{b(1+r_y)} \right) - \frac{\sqrt{\delta_1^2 + \delta_2^2}}{\sqrt{2\pi}b^2} \left(e\left.\frac{-(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}(x-\mu_1-\mu_2)\right|_0^{b(1+r_y)} \right) \\
 & + \frac{(\delta_1^2 + \delta_2^2)}{b^2} \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \phi\left(\frac{\mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & - \frac{(\mu_1 + \mu_2)^2}{b^2} \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \phi\left(\frac{\mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & - \frac{2(\mu_1 + \mu_2)^2}{b^2} \left[\phi\left(\frac{b(1+r_y) - \mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) - \phi\left(\frac{\mu_1 - \mu_2}{\sqrt{\delta_1^2 + \delta_2^2}}\right) \right] \\
 & - \frac{2(\mu_1 + \mu_2)\sqrt{\delta_1^2 + \delta_2^2}}{\sqrt{2\pi}b^2} \left(e\left.\frac{-(x-\mu_1-\mu_2)^2}{2(\delta_1^2+\delta_2^2)}\right|_0^{b(1+r_y)} \right)
 \end{aligned} \tag{4}$$

2.3 Risk pricing coefficients

In the context of the Capital Market Pricing Model (CMPM),

$$\begin{aligned}
 E(R_i) - R_f &= \frac{E(R_m) - R_f}{S_m} \rho_{im} S_i \\
 \frac{\rho_{im} S_i}{S_m} &= \beta_i \\
 E(R_i) &= R_f + [E(R_m) - R_f] \beta_i
 \end{aligned}$$

here S_i is the gap between the risk standards of certain assets, and ρ_{im} is the relevant coefficients between certain assets and the market. Therefore, assume that they have identical relevant coefficients in the market, regardless of whether they have guaranty or not; that is, ρ_{im} is the same in two different techniques.

However, in the context of the selection model of credit-granting techniques, $K = \frac{E(R_m) - R_f}{S_m} \rho_{im}$ has an equivalent value. With regard to the analysis of the relative attraction of the assets, known as risk price, it is equivalent without trap interest. Consequently, the assets pricing model is:

$$E(R_i) = K_i \cdot S_i + R_f \quad (5)$$

2.4 Constructing selection model of credit-granting techniques

In formula (5), suppose that the market risk and yield are given, whether the credit-granted assets have excessive profits over the capital market are not addressed here. The key issue is which of the two credit-granting assets can be more attractive, without guaranty.

In a completely validated capital market, without trap interest, $K = \frac{E(R_m) - R_f}{S_m} \rho_{im}$ value is a risk and yield coefficient, with identical K_i values in the same market. Consequently, with or without guaranty,

$$\begin{aligned} E(R_i) &= K_i \cdot S_i + R_f \\ k_i &= \frac{E(R_i) - R_f}{S_i} \end{aligned} \quad (6)$$

Without guaranty, there are:

$$K_n = \frac{E(R_n) - R_f}{\sqrt{D(R_n)}}$$

With guaranty, there are:

$$K_y = \frac{E(R_y) - R_f}{\sqrt{D(R_y)}}$$

Here, K_i is the pricing coefficient of assets risk. When K_i value increases, it demonstrates that the yield has more tendency to be higher under the unit risk. In light of this relationship, the risk price coefficient of two different credit-granting assets can be derived. Consequently, the techniques with greater K_i value can be more beneficial.

$$\begin{aligned} \text{If: } K_n &= \frac{E(R_n) - R_f}{\sqrt{D(R_n)}} = K_y = \frac{E(R_y) - R_f}{\sqrt{D(R_y)}} \\ [E(R_n) - R_f] \cdot \sqrt{D(R_y)} &= [E(R_y) - R_f] \cdot \sqrt{D(R_n)} \end{aligned}$$

Then, given that $K_n = K_y$

Two assets are equally attractive without any trap interest.

If: $[E(R_n) - R_f] \cdot \sqrt{D(R_y)} \leq [E(R_y) - R_f] \cdot \sqrt{D(R_n)}$

Then, given that $K_n \leq K_y$

In contrast, given relatively more risk without guaranty, it is supposed to opt for security guaranty.

If: $[E(R_n) - R_f] \cdot \sqrt{D(R_y)} \geq [E(R_y) - R_f] \cdot \sqrt{D(R_n)}$

Then, there are: $K_n \geq K_y$

Given that the risk is relatively low without guaranty and with some trap interest, guaranteed credit granting is the option.

To sum up,

$$K_n ? K_y \quad (7)$$

In other words, this is the selection model of credit granting. In terms of the size difference between them, the enterprise can ensure whether credit granting needs guaranty.

3 Empirical studies

It is relatively difficult to gather the data from business credit-granting objects; and the credit-granting standards are not uniform. As business credit granting and commercial bank loans have identical features, samples for empirical studies are drawn from the loan data of one commercial bank branch of the sole proprietorship, and the research scope is restricted to dynamic capital loans for medium-sized and small businesses. Before the bank extends the loan, it evaluates the credit scoring of the individual business or project in order to reduce the degree of risk and to increase the coefficient of loan security. At the moment, the principal assessment indices embody operators' quality and performance, corporate capital structure, corporate profitability, corporate development outlook and the like.

A large number of the loan clients in cities, where commercial banks are located, do not have strong economic power. Therefore their credit scoring is placed at BBB-level and BB-level. Here, the samples come from data involving borrowers at BBB-level and BB-level. Based on the research requirements and availability of the relevant financial and loan data from clients, samples have come from 70 borrowers for one-year-term and are selected from all the medium-sized and small businesses, which were granted loans from the commercial banks in 2005. The detailed composition of these loans is presented in Tab. 1.

Table 1. Sample data.

Sample level	Number of business loan samples		Number of industrial loan samples	
	Credit	Guarantee	Credit	Guarantee
BBB-level	4	17	7	15
BB-level	3	7	4	13

When the data are selected, distinction between business loans and industrial loans is made in order to bridge the gap and make the samples more homogeneous in the empirical study, because the selection model is based on rational selection for the same loan. When guaranty samples are selected, adequate preparations in contemplation and selection are made, because different guaranty techniques have some bearing on credit risk and they further affect the loan interest rate. Consequently, there is little or no difference in terms of guaranty techniques.

After the sample data are selected, the hypotheses have been treated. In this study, the selection of sample data can be made to meet the requirements of basically identical guaranty techniques; therefore, the guaranty value, guaranty square difference and the loan may have certain proportional relationship. In practice, although banks evaluate the businesses, they do not make statistical analysis of the square difference of the corporate assets value in general. In this empirical study, combined with different credit scoring, the expected assets value and square difference can be assumed in terms of the average assets liability rate. In this sample, borrowers at the BBB-level have an average assets liability rate of 59%, and those at the BB-level have an average assets liability rate of 67%. Based on the ratio between assets and liabilities, the ratio between assets and debt can be derived by calculation. In this study, expected asset value of borrowers at the BBB-level and BB-level are set as 170% and 150% respectively, in terms of the amount of the loan. The assumption is that assets fluctuation rate of the businesses at the BBB-level and BB-level is 30% and 40% respectively. Previous research reveals that average survival period of medium-sized and small businesses in China currently is 3.2 years and the annual bankruptcy rate is 31%. Considering the assumptions of expected assets value and square difference of the guaranteed assets, the credit loan rate of the sample bank is approximately 25%, and 75% of the loan can be considered as with guaranty. Consequently, the expected value of the guaranty is assumed to be 75% of the loan. Considering the imperfect guaranty laws and non-uniform guarantee operations, there are many cases of illegal guaranty agencies and invalid guaranties. Therefore, the fluctuation rate of guaranteed assets is set as 50%, which is relatively high. Interest rate of one-year-term savings is 2.35%, which can be seen as the risk-free interest rate. The four combination samples are derived by calculation.

Table 2. Risk price and the expected yield of four combinations.

Sample assessing index	Loan approaches of the sample	BBB-level Industrial loan	BBB-level business loan	BB-level industrial loan	BB-level Business loan
Risk compensation k value	Guarantee	0.82934	0.86059	0.30461	0.38143
	Credit	0.27714	0.30000	-0.02530	0.04333
Expected yield	Guarantee	0.05033	0.05153	0.04792	0.05528
	Credit	0.05563	0.05854	0.00575	0.03267

4 Ave-based n-tier expansion and business collaborative credit-granting monitoring mechanisms

The selection model of AVE business credit-granting approaches is proper for the forward enterprises to select the backward enterprises involving the credit-granting techniques, and subsequently it can be extended to the overall supply chain. A credit-granting monitoring system can be built by leading enterprises in AVE and promotion is achieved in the same or converse direction. Selection of credit-granting guaranty techniques and credit granted may be altered in the operational processes. They are mainly adjusted in terms of the credit capacity and product absorbing capacity of the credit-granting businesses. That is, credit granting with guaranty can be transformed into credit granting without guaranty and the credit granted can increase, or vice versa. When the leading enterprises in AVE transform their products and services, business objects in the AVE chain might be changed. The selection of the credit-granting guaranty techniques and the monitoring process will restart. At this moment, the business collaborative credit-granting monitoring mechanisms will be established in the overall AVE chains and n-tier expansion will be achieved, as illustrated in Fig. 1.

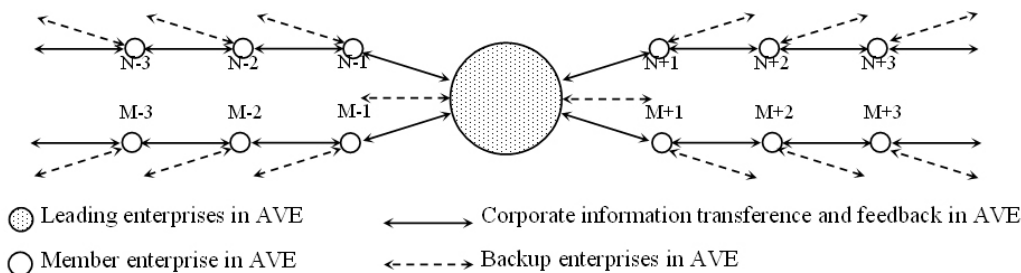


Fig. 1. N-tier expansion model of ave-based corporate credit granting collaborative monitoring.

Some problems are to be resolved pertaining to the realization of n-tier expansion of the AVE-based business credit granting in the collaborative monitoring mechanisms. Considering the stimulation and penalty mechanisms of transference and feedback of credit-granting monitoring information, they can be promoted or constrained by the leading enterprises in AVE. Considering the transference and feedback platform for credit-granting monitoring information, it is necessary to build a corresponding information system based on the network. Considering the two-way information flow from and to the credit-granting monitor, the objects of transference and feedback are supposed to be between the forward and backward enterprises and between leading and member enterprises across different tiers. Considering the business credit, public disclosure of this type of information is not seen as desirable. Considering the issue of validity of AVE-based business credit-granting monitoring in AVE, it is still subject to the internal monitoring mechanism and other collaborative mechanisms of all the enterprises.

N-tier expansion mechanisms of AVE-based business collaborative credit-granting monitoring are subject to one monitoring chain and able to achieve a self-control mechanism chain, thereby facilitating completion of distant credit risk monitoring and disruption of the overall AVE. This notion and mechanism might be deployed for quality system monitor of AVE’s product chains or research and development in new products. Meanwhile, it can be integrated with the CPFR system on the basis of AVE.

5 Conclusion

In the context of the BBB-level and BB-level, the enterprises with better credit scoring at the BBB-level have higher risk compensation price. BBB-level loans have higher risk compensation price than BB-level loans, whether with guaranty or credit. Consequently, the banks are more likely to opt for the clients with better credit scoring. In the same way, the business collaborative credit granting in AVE is also more likely to opt for the objects with better credit scoring.

Whether at the BBB-level or BB-level, loans with guaranty have higher risk compensation price than loans with credit. In the context of the credit loans for businesses at the BB-level, the price is rather low. The expected yield is not enough to compensate for the risk borne by the bank. Consequently, the loan risk compensation price becomes negative for industries at the BB-level. k value of business credit loans at the BB-level is far lower than that of other techniques. As a result, the bank is supposed to reduce credit loans, particularly for enterprises at the BB-level or lower. Similarly, credit granting in AVE enterprises at the BB-level or lower and credit-granting alterations in the operational processes are supposed to take the form of guaranty.

The business loan is slightly more advantageous than the industrial loan in terms of the expected yield and risk compensation price difference. This suggests that the business loan is more advantageous than industrial loan in the case of the sample bank. It might be followed that the range of credit granting can be reasonably enlarged for AVE businesses.

The risk price with guaranty is several times of the credit in these four samples. This demonstrates that loan with guaranty is entirely placed under the trap interest in terms of loan with credit, which mirrors the status quo of the current finance difficulty for medium-sized and small businesses. Consequently, the bank is supposed to relax the constraints on guaranty for businesses at the BBB-level. It follows that the restrictions are supposed to be relaxed in relation to guaranty for enterprises in AVE business credit granting. That is, too rigorous requirements might make enterprises lose many potential channels and clients.

The selection model of AVE business credit-granting techniques is proper for the forward enterprises to choose their backward enterprises pertaining to the credit-granting techniques, and then it could be expanded to the whole supply chain. The selected credit-granting techniques and quantity might be altered in the course of AVE production and operation and subsequently they can be adjusted in tune with reality in time. N-tier expansion mechanisms of AVE-based business collaborative credit-granting monitoring are subject to one monitoring chain and can achieve a self-control mechanism chain, for the benefit of the distance credit risk monitoring and disruption of the overall AVE.

Some problems are to be further investigated pertaining to the realization of n-tier expansion of the AVE-based business credit granting in collaborative monitoring mechanisms, such as the stimulation and penalty mechanisms of the shift and feedback of credit-granting monitoring information; the transference and feedback platform of the credit-granting monitoring information; and the issue of validity of credit-granting monitoring and the like. All these problems will be addressed in future research.

References

- [1] E. Altman, V. Kishore. Almost everything you wanted to know about recoveries on defaulted bonds. *Financial Analysts Journal*, 1996, **11-12**: 57–64.
- [2] E. Altman, A. Saunders. Credit risk measurement: developments over the last 20 years. *Journal of Banking & Finance*, 1997, **11-12**: 1721–1742.
- [3] E. Altman, H. Suggitt. Default rates in the syndicated bank loan market: a mortality analysis. *Journal of Banking & Finance*, 2000, (1-2): 229–253.
- [4] B. Belkin, S. Suchower, L. Forest. The effect of systematic credit risk on loan portfolio value at risk and loan pricing. *Creditmetrics Monitor, First Quarter*, 1998, 17–28.
- [5] M. . Company. Credit portfolio view. McKinsey Inc., New York, 1997.
- [6] M. Crouhy, D. Galai, R. Mark. A comparative analysis of current credit risk models. *Journal of Banking & Finance*, 2000, (1-2): 59–117.
- [7] W. Davidow, M. Malone. *The Virtual Corporation: Structuring and Revitalizing the Corporation for the 21st Century*. Harper Collins Publishers, Inc., New York, 1992.

- [8] G. Delianedis, R. Geske. Credit risk and risk neutral default probabilities: information about rating migrations and defaults. 2003.
- [9] M. Johnson. Collaboration data modeling: Cpfr implementation guidelines. **in:** *1999 Annual Conference Proceedings of the Council of Logistics Management*, Syncra Systems Inc., One Cambridge Center Cambridge, MA 02142, 1999.
- [10] KMV. Credit monitor overview. KMV Corporation, San Francisco, 1993.
- [11] KMV. Kmv and credit metrics. KMV Corporation, San Francisco, 1997.
- [12] J. Morgan. *Credit Metrics*. Technical Document, New York, 1997.
- [13] R. Nagel, R. Dove. *21st Century Manufacturing Enterprise Strategy*. Iacocca Institute, Lehigh University, Bethlehem, PA, USA, 1991.
- [14] B. C. on Banking Supervision. Credit risk modeling: Current practice and applications. Basle, 1999.
- [15] M. Pesaran, T. Schuermann, etc. Macroeconomic dynamics and credit risk: a global perspective. *Journal of Money, Credit & Banking*, 2006, (5): 1211–1261.
- [16] C. S. F. Products. Credit risk plus: Technical document. Credit Suisse, London/New York, 1997.
- [17] W. Sharpe. Imputing expected security returns from portfolio composition. *Journal of Financial and Quantitative Analysis*, 1974, **3**: 463–472.
- [18] T. Wilson. *Credit Risk Modeling: A New Approach*. McKinsey Inc., New York, 1997.