Research on the Game of Securitization Based on Blockchain Technology

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Keywords: Blockchain, Securitization, Game model, Credit mechanism.

Abstract. In view of the advantages of decentralization, reliability and unmodification of Blockchain technology, an incomplete information game model of traditional securitization and a complete information game model of Blockchain securitization are established based on securitization business process and credit mechanism. By conducting empirical analysis on the issuing data of Jingdong White Bar asset-backed security, this paper compares the securitization revenue of SPV corporation and investors under those two circumstances when reaching Nash equilibrium, and results indicate that securitization of Blockchain pattern has outstanding advantages of operating cost reduction, risk management and profit increase over traditional securitazation.

1. Introduction

Securitization, which means issuing security supported by future cash flow of asset and increasing credit rating, disperses risk to each participant in portfolio market. However, it cannot eliminate systematic risk and information destruction[1]. During the process of traditional securitization, Special Purpose Vehicle(SPV)corporation manages the asset pool and issues asset-backed security. In order to obtain the maximal payoff, SPV may conceal the risk of asset by selling junior security at a high price. Due to the existence of asymmetric information, the interest of security investors may be damaged[2].

With the development of financial technology, Blockchain technology has been in use of securitization. It eliminates information destruction between financial intermediaries and investors in the following three ways:

(1) Proof-of-work mechanism: By connecting data block chronologically, trading information can be updated on distributed ledger by proof-of-work mechanism, which can be seen by both intermediaries and investors[3].

(2) Cryptology application: By applying cryptology technology, it guarantees the authenticity of information which cannot be falsified.

(3) Smart contract: It is a program designed to guarantee that due cash should be paid off automatically.

2. Game Research on Securitization

During the process of traditional securitization, investors accepted the asset information passively from SPV and credit rating agency who may jeopardize the interest of investors using asymmetric information. Thus, we design two game models between SPVs and investors based on traditional securitization and Blockchain securitization.

2.1. Assumptions

(1) SPV is the security issuer and we don’t consider other intermediary except SPV.

(2) There are only two kinds of assets in the model and their payoff is independent from each other.

(3) All the investors are risk-averse.
(4) Reinvestment interest rate is market interest rate.

2.2. Portfolio Design

According to the portfolio theory, payoff of two-asset portfolio *P* can be denoted as

$$r_p = w_A r_A + w_B r_B \tag{1}$$

Where $w_A + w_B = 1$, w_A, w_B represent the amount ratio of asset A and asset B, r_A, r_B describe the yield to maturity of asset A and asset B. On one hand, in order to obtain the maximization of utility, the optimal investment design is

$$w_A = \frac{E(r_A) - E(r_B) + 0.01A\sigma_B^2}{0.01A(\sigma_A^2 + \sigma_B^2)} \tag{2}$$

$$w_B = 1 - w_A \tag{3}$$

where A denotes risk aversion coefficient. Variance σ measures the risk of asset yield to maturity. σ_A, σ_B denote default risk of asset A and asset B. On the other hand, in order to minimize risk, the optimal investment design is

$$w_A = \frac{\sigma_B^2}{\sigma_A^2 + \sigma_B^2} \tag{4}$$

$$w_B = \frac{\sigma_A^2}{\sigma_A^2 + \sigma_B^2} \tag{5}$$

2.3. Yield to Maturity of Portfolio

Let *P* denote portfolio price, *F* denote par value of portfolio, h represent portfolio interest per period, r represent yield to maturity and n is the amount of interest period. Using the method of discounting cash flow, we can discount future payoff:

$$P = \frac{h}{1+r} + \frac{h}{(1+r)^2} + \cdots\cdots + \frac{h}{(1+r)^n} + \frac{F}{(1+r)^n} \tag{6}$$

Since there exists default risk of asset, the actual yield rate is $r(1-\sigma)$.

2.4. Establishment of Game Model

SPV and investor are two parties in the game model. In order to increase the portfolio credit, the issuer will hold certain amount of junior security[4]. Thus, the action set of issuer will be (hold, not hold) while the action set of investor will be (invest, not invest). As shown in Fig.1.

2.5. Game Analysis on Traditional Securitization

Due to the information destruction effect, SPV will conduct the portfolio design which maximizes utility[5]. And SPV will bear the issuing cost at the same time. Since there exists asymmetric information between SPV and investor, we assume that SPV will use the future cash flow of asset *B* (with higher risk) to pay the portfolio interest of investor. And we have four action profiles.

(1) SPV holds junior security, investors invest

SPV holds security B and bear the cost C. Let u denote interest rate of future cash flow. On the one hand, SPV receives cash pu; on the other hand, SPV pays investors $pr(1-\sigma)$. Investors receive

the cash flow from asset B with higher risk. Let (C11, D11) represent the payoff of SPV and investor:

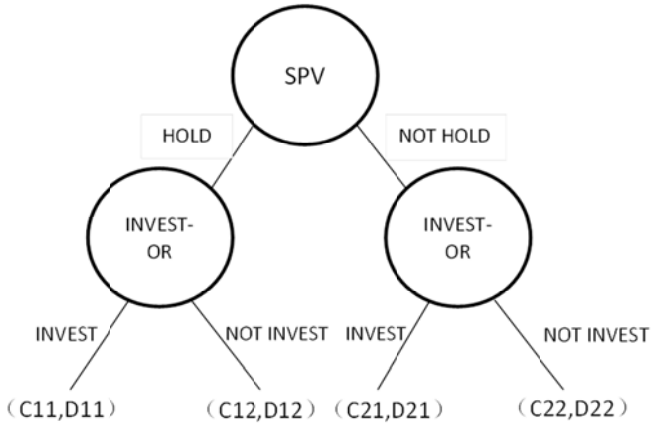

Figure 1. Game Tree of Securitization

$$C_{11} = p_B r_B (1-\sigma_B) + w_A p_A u_A + w_B p_B u_B - p_B r_B (1-\sigma_B) - C \tag{7}$$

$$D_{11} = p_B r_B (1-\sigma_B) \tag{8}$$

(2) SPV holds junior security, investors don't invest

SPV holds security B and bear the cost C. Investors apply $(w_A p_A + w_B p_B)$ cash to other investment with market interest rate i. Let (C12,D12) represent the payoff of SPV and investor:

$$C_{12} = p_B r_B (1-\sigma_B) - C \tag{9}$$

$$D_{12} = i(w_A p_A + w_B p_B) \tag{10}$$

(3) SPV doesn't hold junior security, investors invest

SPV doesn't hold security but bear the cost. Investors receive interest of asset B. Let (C21, D21) represent the payoff of SPV and investor:

$$C_{21} = (w_A p_A u_A + w_B p_B u_B) - p_B r_B (1-\sigma_B) - C \tag{11}$$

$$D_{21} = r_B p_B (1-\sigma_B) \tag{12}$$

(4) SPV doesn't hold junior security, investors don't invest

SPV doesn't hold security but bear the cost. Investors apply $(w_A p_A + w_B p_B)$ cash to other investment with market interest rate i. Let (C22, D22) represent the payoff of SPV and investor:

$$C_{22} = -C \tag{13}$$

$$D_{22} = i(w_A p_A + w_B p_B) \tag{14}$$

2.6. Game Analysis on Blockchain Securitization

Complete information can be obtained with Proof of Work mechanism. Meanwhile, the issuing cost C, including agency expense, credit rating expense, etc, can be saved. As for investor with risk aversion, they will conduct the portfolio design with minimum risk. And investors will receive the interest from asset *A* and asset *B*.

(1) SPV holds junior security, investors invest

With no issuing cost, SPV holds security B and pays interest to investors. SPV receives future cash flow pu while investors receive interest pr (smart contract eliminates certain default risk). Let($C_{11}^{'}, D_{11}^{'}$)denote the payoff of SPV and investors:

$$C_{11}^{'} = p_B r_B + w_A^{'} p_A (u_A - r_A) + w_B^{'} p_B (u_B - r_B) \tag{15}$$

$$D_{11}^{'} = w_A^{'} p_A r_A + w_B^{'} p_B r_B \tag{16}$$

(2) SPV holds junior security, investors don't invest

SPV holds security B. Investors apply $(w_A p_A + w_B p_B)$ cash to other investment with market interest rate i. Let($C_{12}^{'}, D_{12}^{'}$) represent the payoff of SPV and investor:

$$C_{12}^{'} = p_B r_B \tag{17}$$

$$D_{12}^{'} = i(w_A^{'} p_A + w_B^{'} p_B) \tag{18}$$

(3) SPV doesn't hold junior security, investors invest

SPV doesn't hold security. Investors receive interest of asset B. Let($C_{21}^{'}, D_{21}^{'}$) represent the payoff of SPV and investor:

$$C_{21}^{'} = w_A^{'} p_A (u_A - r_A) + w_B^{'} p_B (u_B - r_B) \tag{19}$$

$$D_{21}^{'} = w_A^{'} p_A r_A + w_B^{'} p_B r_B \tag{20}$$

(4) SPV doesn't hold junior security, investors don't invest

SPV doesn't hold security but bear the cost. Investors apply $(w_A p_A + w_B p_B)$ cash to other investment with market interest rate i. Let($C_{22}^{'}, D_{22}^{'}$) represent the payoff of SPV and investor:

$$C_{22}^{'} = 0 \tag{21}$$

$$D_{22}^{'} = i(p_B w_B^{'} + p_A w_A^{'}) \tag{22}$$

3. Empirical Analysis on Jingdong Baitiao Asset Support Special Plan

Jingdong Baitiao asset support special plan was quoted on Shenzhen Stock Exchange in October 2015. It was the first asset backed securitization based on Internet consumer finance.

Table 1. Issuing Data of Jingdong Baitiao Asset Support Special Plan

Security	Maturity (year)	Yield to Maturity	Coverage Rate	Issuing Scale (million yuan)	Par Value (yuan)
A	2	5.10%	6.8%	6	100
B	2	7.30%	8.4%	1.04	100

Using the data of Jingdong Baitiao asset support special plan, we conduct an empirical analysis on traditional securitization and Blockchain securitization.

3.1. Payoff of Traditional and Blockchain Securitization

Let default probability σ_A of asset A be 0.6 and σ_B of asset B be 0.8. And we assume that

market interest rate be 4%. Since it is difficult to calculate issuing cost in traditional securitization, we remain the cost C in the payoff result. Payoff of traditional securitization and Blockchain securitization are presented in picture.

Table 2. Payoff of Traditional and Blockchain Securitization

Mode	Investor Action	SPV hold security B	SPV doesn't hold security B
Traditional Securitization	Invest	(7.728-C,4.380)	(3.348-C,4.380)
	Not Invest	(4.380-C,4.000)	(-C,4.000)
Blockchain Securitization	Invest	(5.822,6.046)	(1.442,6.046)
	Not invest	(4.380,4.000)	(0,4.000)

3.2. Result Analysis

According to the results of game model in two modes of securitization, we conduct a comparison analysis on the payoff:

(1) The maximum payoff of traditional securitization is (7.728-C, 4.380) while Blockchain securitization is (5.822, 6.046). The action profile of Nash equilibrium under these two modes securitization is that SPV holds security *B* and investors choose invest.

(2) Comparing the payoff of the two modes, investors can gain 6.046 with Blockchain technology, which is 38% more than that of traditional securitization. This is because Proof of Work mechanism eliminates the information asymmetry between issuer and investor, thus reducing the systematic risk. And the smart contract of Blockchain technology guarantees the payment of due cash. thus eliminating the default risk.

(3) The payoff of SPV in Blockchain mode is 5.822 while the payoff in traditional mode is 7.728-C. Accordingly, whether the payoff of SPV will be increased depends on the issuing cost.

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