

Original Paper

Research on the Pricing of Green Asset Securitization: A case Study of “Yingfeng 2024-1 ABS”

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Abstract

To address global environmental challenges, green finance has embraced green asset securitization (Green ABS) as an innovative tool, reducing corporate financing costs and meeting investors' risk diversification needs. However, current Green ABS pricing largely relies on traditional securitization frameworks, failing to fully leverage green attributes and undermining product competitiveness. Using the “Yingfeng 2024-1 Asset-Backed Securities” as an empirical case, this paper analyzes Green ABS pricing models, summarizes existing research, identifies systemic deficiencies, and proposes a comprehensive pricing structure. Integrating the CIR model, option-adjusted spread, and Monte Carlo simulation for interest rate forecasting, coupled with multiple linear regression for issuing spread assessment, the model derives discount rates and theoretical valuations. Analysis of the “Yingfeng 2024” project—covering asset composition, cash flow projections, and rate simulations—yields a theoretical value of 2.095 billion yuan, marginally higher than the actual issuance price. Finally, measures to optimize information disclosure, standardize third-party certification, and promote green investment are proposed to support stable market growth and rational pricing for issuers and investors.

Keywords

Green asset securitization, Monte Carlo simulation, Option-adjusted spread method

1. Introduction

In light of escalating global environmental challenges and the urgent need for sustainable development, green asset securitization has emerged as a pivotal innovative instrument in green finance. It channels private capital into low-carbon projects while offering investors diversified risk-return profiles. However, the existing pricing mechanism does not fully capture the intrinsic value of green attributes, as traditional valuation models struggle to quantify environmental premiums and the impacts of policy

support. This paper utilizes “Yingfeng 2024-1ABS” as a case study, integrating the CIR model, Option-Adjusted Spread technology, and Monte Carlo simulation to construct a dynamic pricing framework. Through multiple linear regression analysis, it quantifies the influence of green certification, issuer credit quality, and sustainability metrics on issuance spreads. This provides issuers with actionable insights to optimize pricing strategies and enhances investor confidence in green financial products.

2. Construction of Pricing Model for Green Asset Securitization

2.1 Model Selection

2.1.1 Option Adjustment Spread Method

The OAS strategy employs risk-free arbitrage to price options by simulating interest rate uncertainty. It adjusts the OAS to align theoretical values with market values and demonstrates the dynamic impact of interest rate and prepayment risks on the value of securities [1].

The calculation formula is shown below [2]:

$$P = \frac{1}{N} \sum_{n=1}^N \sum_{t=1}^T \frac{CF_t^n}{(1+r_t^n + OAS)^t} \quad (1)$$

Among them, N represents the number of simulated interest rate paths; r_t^n Indicate the benchmark interest rate for the n th path during the t -th period; CF_t Representing the cash flow under the n th path during the t -th period; OAS stands for issuance spread.

2.1.2 CIR Model

The Cox-Ingersoll-Ross (CIR) model significantly differs from previous models in that it posits a consistent positive correlation between interest rates and their instantaneous fluctuations. Specifically, when short-term interest rates increase, the range of interest rate fluctuations expands considerably. This hypothesis effectively reduces the probability of negative interest rates to zero, thereby curtailing the potential for unlimited arbitrage behavior among investors. The specific calculation formula is presented below [3].

$$dr = \alpha(\mu - r)dt + \sigma\sqrt{r}dw_t \quad (2)$$

Among them, α Speed of restoring short-term interest rate r to μ , Long term mean μ , The short-term interest rate volatility is constant, dwt represents standard Brownian motion [4].

Due to the fact that the CIR model only considers continuous interest rates, while most observed rates in reality are discrete, the CIR model has been reformulated as follows [5].

$$R_{t+\Delta} - R_t = \alpha(\mu - R_t)\Delta + \sigma\sqrt{R_t}\varepsilon_t \quad (3)$$

To estimate the parameters of interest rates, namely a , b , and c , for the purpose of predicting future interest rates, the maximum likelihood method is typically employed for estimation. Subsequently, the calculations are performed using MATLAB software.

2.1.3 Monte Carlo Simulation of Interest Rate Path

After estimating the parameters of the CIR model, an appropriate initial interest rate level is selected. The Monte Carlo simulation method is then employed to generate interest rate paths for various periods, which are subsequently applied to the CIR model to produce N different future interest rate paths. These interest rate paths are then converted into spot interest rate forms, resulting in a comprehensive spot interest rate path. The calculation formula is provided in Equation (4), where r_t is the spot interest rate under a certain interest rate path at time t, and is the corresponding simulated forward interest rate [6].

$$r_t = [(1+f_1)(1+f_2)\dots(1+f_t)]^{\frac{1}{t}} \quad (4)$$

2.2 Multiple Regression Model for Pricing

2.2.1 Constructing a Multiple Regression Model

Accurately estimating capital costs is central to pricing green asset securitization, necessitating comprehensive verification of multiple factors. Green securitization rates differ significantly from traditional ones due to adjustments in capital costs driven by environmental characteristics. In constructing price models, it is essential to evaluate environmental factors such as green certification and the effectiveness of emission reductions to accurately reflect market rates[7][8]. This study develops a multiple linear regression model to analyze the impact of various variables on issuance spreads, incorporating factors like green certification, issuer nature, issuance scale, credit rating, market environment, and policy support to enhance pricing accuracy. A sample analysis of 475 green asset securitization products from 2018 to 2023 was conducted, excluding green bonds that lacked key pricing information. The focus was on variables such as issuance scale, repayment period, credit evaluation, and third-party green certification[9].

2.2.2 Variable Settings

In this study, the issuance spread of green asset-backed securities is designated as the dependent variable, defined as the difference between the issuance interest rate of the securities and the yield of a one-year Treasury bond. Concurrently, the issuance period, issuance scale, subject credit rating, and third-party green certification are selected as independent variables, as these factors are believed to significantly influence the pricing of green bonds. The specific variables are presented in Table 1.

Table 1. Multivariate Linear Regression Variables

variable name	Variable Description	Possible range of values/calculation methods
dependent variable		
Issuance spread (R)	Issuing interest rate minus one-year treasury bond yield, in percentage (%)	Value, representing additional risk compensation rate, such as 0.5%, 1.0%, 1.5%, etc.

independent variable		
Scale	The logarithm of the total issuance amount reflects the strength and liquidity of the enterprise	Take the natural logarithm of the total issuance amount
Year	Product duration (years), the longer the duration, the higher the risk compensation requirements	Numerical values, such as 3 years, 5 years, 10 years, etc.
Credit	Bond credit rating, numerical representation (AAAsf=4, AA+=3, AA=2, A+=1)	1、2、3、4, Corresponding to different credit rating levels.
Subject nature (Nature)	State owned enterprise=1, otherwise=0	0 or 1, binary variable。
Regulator	Whether the regulatory agency is the China Securities Regulatory Commission or the Securities Dealers Association=1. Other situations are 0	The China Securities Regulatory Commission or the Securities Dealers Association are binary variables, with values of 0 or 1 respectively
Third party green certification (Certification)	Has it undergone third-party green certification? Yes=1, otherwise=0	0 or 1, binary variable

2.2.3 Multiple Regression Results

In this study, we employed Stata 17 software to conduct multiple regression analysis on the selected sample data. To ensure the robustness of the model, we specifically incorporated the standard error of the heteroscedasticity matrix during the analysis to effectively address potential heteroscedasticity issues. The results indicated that the Variance Inflation Factor (VIF) values for all variables were below the acceptable threshold, signifying the absence of significant multicollinearity issues within the model. The regression results are presented in Table 2.

Table 2. Multiple Regression Results

variable name	coefficient	VIF	p 值
Scale	-0.078	1.234	0.001
Year	0.035	1.13	0.001
Credit	-0.152	1.345	0.001
Nature	-0.058	1.098	0.033
Regulator	-0.285	1.156	0.002
Certificatio)	-0.080	1.087	0.001

Constant	1.680	-	-
Observed value	475		
Adjusted R ²	0.5432		

Regression results show all variable coefficients align with expectations and are significant. Larger issuance scale (size_ln: -0.078, $p < 0.001$), higher debt rating (-0.152, $p < 0.001$), third-party green certification (-0.080, $p = 0.001$), state-owned enterprise status (0.058pp lower, $p = 0.033$), and CSRC regulation (0.285pp lower, $p < 0.001$) reduce issuance rates; longer tenor increases rates (0.035, $p < 0.001$). Model $R^2 = 0.5432$ with no serious multicollinearity ($VIF < 5$).

Based on the above regression results, the predictive model for the spread of green asset securitization issuance is obtained as follows:

$$R = -0.078\text{Scale} + 0.035\text{Year} - 0.152\text{Credit} - 0.058\text{Nature} - 0.258\text{Regulator} - 0.080\text{Certification} + 1.68$$

3. Pricing Case Analysis of the “Yingfeng 2024” Project

In the pricing process, the spread is calculated using cash flow forecasting, interest rate path simulation—based on the Cox-Ingersoll-Ross (CIR) model and Monte Carlo simulation—along with a multiple regression model. This approach is combined with the option-adjusted spread (OAS) method to determine its theoretical value.

3.1 Information on the “Yingfeng 2024” Project

3.1.1 Basic Information

Dongfeng Motor Finance Co., Ltd. (Dongfeng Motor Finance) has successfully issued “Yingfeng 2024-1ABS” in the interbank bond market, raising 2.09 billion yuan. This project is based on 36,000 personal new energy vehicle loans as underlying assets, with priority securities receiving an issuance interest rate of 1.75%, which sets a new low for asset-backed securities (ABS) interest rates in the automotive finance industry during the same period. The subscription multiple of 2.33 times indicates the market’s positive recognition of green financial products. Through its securitization operations, Dongfeng Motor Finance achieves the dual objectives of realizing existing assets and enhancing financing capabilities. The released capital of 1.2 billion yuan will be specifically allocated for the issuance of new energy vehicle consumption loans, thereby forming a virtuous cycle of “asset activation - fund recovery - green investment.”

3.2 Pricing Process

3.2.1 Cash Flow Forecast

According to the project plan statement of “Yingfeng 2024”, the predicted future cash flows are shown in Table 3.

Table 3. Future Cash Flow Forecast

Trust accounting date	Initial total principal balance	Current principal receivable	Interest receivable for this period	Sum of cash flows
2024-12	2,237,241,950.15	58,932,759.83	832,292.37	2,178,309,190.32
2025-1	2,178,309,190.32	79,764,060.74	7,825,904.7	2,098,545,129.58
2025-2	2,098,545,129.58	70,688,322.3	7,657,138.53	2,027,856,807.28
2025-3	2,027,856,807.28	87,280,442.64	7,563,242.74	1,940,576,364.64
2025-4	1,940,576,364.64	85,496,546.64	7,612,248.83	1,855,079,818.00
2025-5	1,855,079,818.00	84,195,113.75	7,396,203.41	1,770,884,704.25
2025-6	1,770,884,704.25	86,012,676.55	71,455,585.13	1,684,872,027.70
2025-7	1,684,872,027.70	56,708,385.43	6,808,193.97	1,628,163,642.27
2025-8	1,628,163,642.27	56,875,159.94	6,639,539.68	1,571,288,482.33
...	...	...	...	...
2029-3	37,178,751.11	13,799,226.18	175,391.89	23,379,524.93
2029-4	23,379,524.93	11,275,320.25	110,232.04	12,104,204.68
2029-5	12,104,204.68	8,477,284.04	57,338.05	3,626,920.64
2029-6	3,626,920.64	3,626,920.64	17,480.22	-

3.2.2 Interest Rate Path Simulation

The “Yingfeng 2024” project has a duration of five years, with the value date set for October 30, 2024. For the interest rate path simulation, this paper utilizes the five-year Treasury bond yield from 2019 to 2024 as the benchmark interest rate. It is important to note that the CIR model is primarily employed to characterize the dynamic changes in short-term interest rates. The parameters of this model include the mean reversion speed (α), the long-term mean (μ), and the volatility (σ) [10][11]. Assuming an annualized interest rate for each period, it can be expressed using Equation (5).

$$r_t = \frac{\text{Interest receivable}_t \times 365}{\text{Initial}_t \times \text{Interest Calculation Days}} \quad (5)$$

The estimation results of CIR model parameters obtained through Matlab calculation are $\alpha=0.5006$, $\mu=0.0206$, $\sigma=0.0309$. By substituting them into the CIR model, we can obtain below formular[12]:

$$dr_t = 0.5006(0.0206 - r_t)dt + 0.0309\sqrt{r_t}d\omega_{\&t} \quad (6)$$

According to CIR model parameters $\alpha=0.5006$, $\mu=0.0206$, $\sigma=0.0309$, the yield of treasury bond obtained on the issuing day of “Yingfeng 2024” is selected as 1.84%, and then Matlab is used to simulate the forward interest rate path of the next five periods. After simulating 1000 interest rate paths, the fluctuation range of interest rates is shown in Figures 1 and 2:

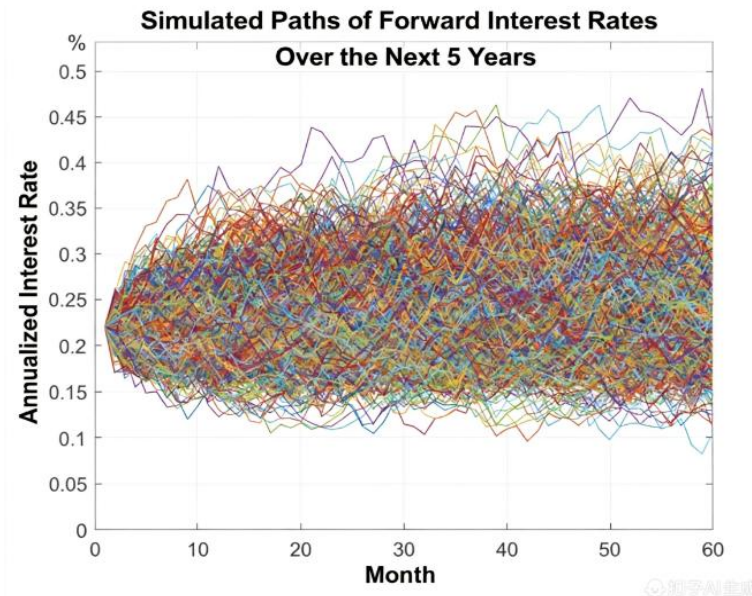


Figure 1. 21000 Simulation of Forward Rate Paths

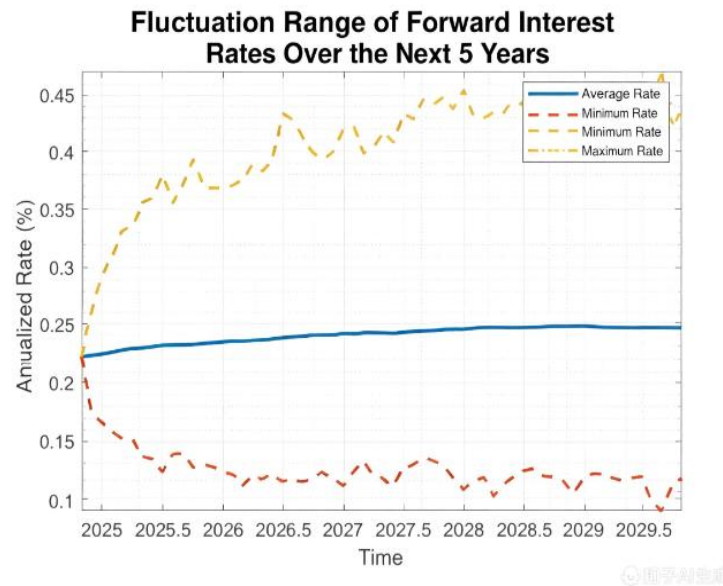


Figure 2. The Fluctuation Range of 1000 Interest Rates

The statistical results of forward rates are shown in Table 4:

Table 4. Simulation Table of Forward Interest Rates for the Next 5 Years

Time	Average interest rate	Minimum interest rate	Highest interest rate
2025.1.1	0.099221	0.081172	0.68345
2026.1.1	0.1007	0.087854	0.55612

2027.1.1	0.69953	0.24136	0.9048
2028.1.1	0.25453	0.020804	0.40918
2029.1.1	0.71445	0.054866	0.70062

According to the simulated forward interest rate path, substitute into the formula [13]:

$$r_t = [(1+f_1)(1+f_2)\dots(1+f_t)]^{\frac{1}{t}} \quad (7)$$

Then convert the forward interest rate into the corresponding spot interest rate, which is part of the discount rate in the option adjustment spread method. After calculating and adjusting the spread, the discount rate can be obtained. The specific simulation results of spot interest rates are shown below.

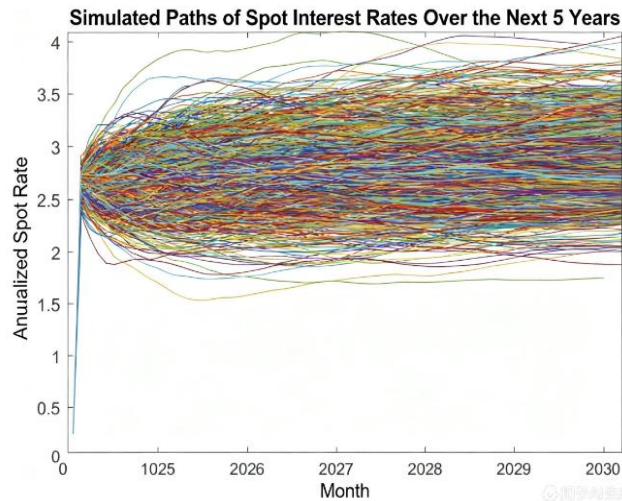


Figure 3. Simulation Diagram of 1000 Interest Rate and Spot Rate Paths

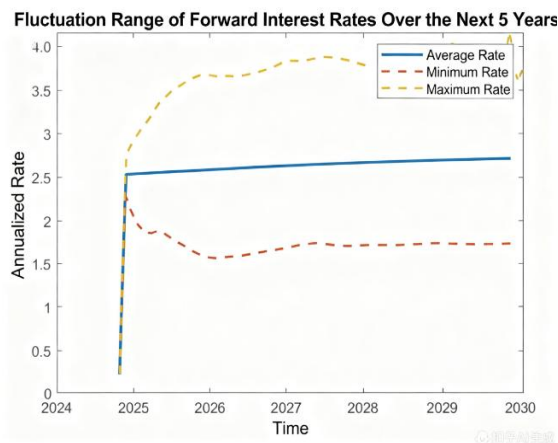


Figure 4. The Fluctuation Range of 1000 spot Interest Rates

Based on the CIR model parameters and simulation code, the following is the generated simulation result table for spot interest rates. The statistical results of spot interest rates are shown in Table 5.

Table 5. Simulation Table of Spot Interest Rates for the Next 5 Years

Time	Average interest rate	Minimum interest rate	Highest interest rate
2025.1.1	0.34896	0.77992	0.84867
2026.1.1	0.38161	0.68766	0.74976
2027.1.1	0.18439	0.084854	0.43355
2028.1.1	0.69044	0.0028291	0.46079
2029.1.1	0.09655	0.34313	0.59777

3.2.3 Determine the Interest Rate Spread

In calculating the pricing of “Yingfeng 2024”, the discount rate must not only consider the spot interest rate but also incorporate a risk compensation spread. Traditional asset securitization pricing methods typically exclude green factors; therefore, this article calculates the spread using a multiple regression model [14]. According to this model, we first establish the relevant variable values for “Yingfeng 2024”: the issuance scale is 2.09 billion yuan, the issuance period is five years, the debt rating is AAA, the issuer is a state-owned enterprise, the regulatory agency is the China Securities Regulatory Commission, and the project has received third-party green certification. The multiple linear regression model estimates the issuance spread (R) of green asset securitization. Key variables include: Scale (natural logarithm of issuance amount: $\ln(2,090,000,000)$), Year (five-year maturity), Credit (4 for AAA rating), Nature (1 for state-owned enterprise), Regulator (1 for CSRC supervision), Certification (1 for third-party green certification), and a constant term of 1.68.

Based on the above regression results, the prediction model for the spread of green asset securitization issuance is as follows:

$$R = -0.078\text{Scale} + 0.035\text{Year} - 0.152\text{Credit} - 0.058\text{Nature} - 0.258\text{Regulator} - 0.080\text{Certification} + 1.68$$

By substituting the values from the table above, the following results are obtained:

$$R = -0.078 \times \ln(2090000000) + 0.035 \times 5 - 0.152 \times 4 - 0.058 \times 1 - 0.285 \times 1 - 0.080 \times 1 + 1.68$$

According to calculations, the interest rate spread for “Yingfeng 2024” is 0.85%.

3.2.4 Pricing Calculation

To calculate the present value (PV) of Path 1, we first obtain the future cash flow forecast data for ‘Yingfeng 2024’ from Table 3-1, where the total cash flow for the first period is 2,178,309,190.32. Next, we derive the spot interest rate path through a Monte Carlo simulation based on the Cox-Ingersoll-Ross (CIR) model, with the average rate for the first period calculated at 0.34896. The interest rate spread is determined to be 0.85%, utilizing a multiple regression model that considers variables such as a 2.09 billion yuan issuance scale, a 5-year term, an AAA rating, a state-owned enterprise issuer, CSRC regulation, and third-party green certification. The discount rate is computed by summing the spot rate and the spread ($0.34896 + 0.85\% = 0.35746$). Finally, we compute the PV value for each path.

$$PV(\text{path 1}) = \frac{2178309190.32}{(1+0.35746)^1}, \quad PV(\text{path 2}) = \frac{2098545129.58}{(1+0.35746)^2}, \dots, PV(\text{path 1000}) = \frac{3626920.64}{(1+0.10505)^{1000}}$$

$$\text{Theoretical value} = \frac{PV(\text{path1}) + PV(\text{path2}) + \dots + PV(\text{path1000})}{1000} = 2.095 \text{ billion yuan}$$

3.3 Pricing Result Analysis

The pricing result analysis of the “Yingfeng 2024” project reveals that its theoretical valuation, derived using an Option-Adjusted Spread model with Monte Carlo simulation incorporating green factors, stands at 2.095 billion yuan, slightly exceeding the actual issuance price. This discrepancy primarily arises from the limitations of mainstream pricing methodologies, which heavily rely on historical data and struggle to account for market structural changes or tail risks during periods of high volatility. Notably, current models inadequately address external variables such as shifts in investor behavior, the impact of economic cycles on capital costs, and evolving carbon policies. A significant challenge lies in accurately quantifying environmental attributes due to the lack of unified green information disclosure standards and effectiveness evaluation frameworks in China, which hinders the translation of green characteristics into tangible price premiums[15]. Market demand fluctuations persist as investors prioritize short-term returns over long-term environmental value, while third-party certification offers only limited advantages in financing costs. This imbalance between market-oriented pricing mechanisms and policy guidance, compounded by uneven participant structures, results in actual transaction prices that do not fully reflect the theoretical value of green asset securitization products.

4. Conclusions

This study constructs a comprehensive pricing model that integrates the CIR model, the Option-Adjusted Spread method, and Monte Carlo simulation to address the limitations of traditional valuation approaches in capturing green attributes. An empirical analysis of the ‘Yingfeng 2024-1 ABS’ project demonstrates the model’s effectiveness, yielding a theoretical value of 2.095 billion yuan, which is slightly higher than the actual issuance price. Key findings reveal that current pricing methodologies insufficiently account for market structural changes, tail risks, and external variables such as shifts in investor behavior and carbon policies. Critical challenges include the lack of unified environmental disclosure standards in China and the difficulties in quantifying green attributes into tangible price premiums, compounded by investors’ focus on short-term returns over long-term environmental value. For investors, this research highlights green asset securitization as a valuable portfolio component that offers stable returns and risk diversification. Recommendations include conducting in-depth pricing analyses that incorporate issuance size, maturity, and credit ratings; prioritizing products with verified green credentials; and maintaining vigilance regarding market dynamics and policy changes to optimize investment strategies amid evolving green finance landscapes.

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