A comparative study on pricing methods of infrastructural assets securitization: a case study of power distributing assets of X mall

Shaozhen Chen¹², Yang Zhang¹, Jinlin He¹

¹Fintech Lab of State Grid e-Commerce Ltd.Co. No.311 Guang’anmen Street, Xicheng District, Beijing. 100038. China.
²State Grid Financial Technology Group Ltd.Co. No.311 Guang’anmen Street, Xicheng District, Beijing. 100038. China.

Email: andy-louis@live.cn

Abstract: Although the securitization technique was widely applied in financial practice, moreover, overseas academics have abundant experience on such field, due to securitization’s late introduced to China, legislate infrastructure such as the supervised legislation and the tax laws are far beyond perfect, not mention the study of the pricing theories on securitization, especially in pricing the securities which backed by such infrastructural assets as electric power distributing network, theoretic research in this area is even rare. This paper conducts a case study, taking the electric-power-distributing asset of a mall as an example, to examine three different pricing methods for valuating asset backed securities, with the purpose to explore more an applicable pricing method for infrastructure asset securitization.

1. Introduction

In recent years, in order to deal with the challenges which exhibit with the dynamic economic situation, Chinese Governments, both national and local, made a series of policies to lead the financial resources to support economy better. Among them, aimed to provide financial support to infrastructure building, financial regulators and supervisors worked out a policy called “An announcement of driving Reits investment experimental unit in infrastructure area”, to push mutual Reits to invest in public utilities such as water, gas, heat and electricity supply, in order to enhance the economy’s competitiveness, in term of offering preferable policies. The establishment of the mutual Reits experimental unit demonstrates its importance by Revitalizing current infrastructural assets, improving the turnover rates and enriching financial instruments in capital markets. Among all the stages in offering infrastructural Reits instruments, one essential step is to securitize the underlying assets, in other words, why this step is important is that pricing the asset-backed-securities in this process properly is the foundation of successful investment.

Although the securitization technique was widely applied in financial practice, moreover, overseas academics have abundant experience on such field, due to securitization’s late introduced to China, legislate infrastructure such as the supervised legislation and the tax laws are far beyond perfect, not mention the study of the pricing theories on securitization, especially in pricing the securities which backed by such infrastructural assets as electric power distributing network, theoretic research in this
area is even rare. This paper conducts a case study, taking the electric-power-distribution asset of a mall as an example, to examine three different pricing methods for valuating asset backed securities, with the purpose to explore more an appliable pricing method for infrastructure asset securitization. The first section is introduction, presents the background and goal of the research; while the second part examines the main valuation measures in securitization briefly by studying both the domestic and oversea academic. The third section introduce the electricity-distribution assets, and analyze the historical cash-flow and key factors of the cash-flow; the forth section begin with an introduction of three different valuation models and the present value of cash-flow of the asset deriving by the former three models. The last section derive a conclusion.

2. Literature

Asset securitization is a form of financing that supports a specific investment portfolio or specific cash flow in the form of issuance of tradable securities. Traditional securities issuance is based on enterprises, while asset securitization is based on a specific underlying asset pool. Asset securitization is a means of transforming illiquid assets into securities that can be freely circulated in the financial market, which can provide enterprises with liquidity. Essentially, the value of securities depends on the size of the future net cash flow of the underlying asset, the distribution of cash flow and the discount rate used.

Regarding the pricing methods of asset-backed securities (ABS), Dr. Xu Dong elaborated on the pricing methods of four asset-backed securities. The four methods are static cash flow rate of return method, static spread method, and total return[1]. Rate scenario analysis method and option-adjusted spread method. Among them, the static cash flow rate of return method is the simplest method. It uses a single yield to maturity for pricing and is widely used in practice; the static spread method is based on the yield curve for pricing, and the cash flow is distributed over several years[2]. Under the state of, the intrinsic price of the securities estimated by this method is more accurate than that obtained by the static cash flow rate of return method; the total rate of return scenario analysis method is a useful extension of the static cash flow rate of return method. It examines The dynamic characteristics of asset-backed securities holding period returns; the option-adjusted spread method uses the Monte Carlo method to simulate a large number of interest rate paths and the performance of asset-backed securities under these paths. In the beneficial extension of the scenario analysis method, this method can be more It simulates the probability distribution of future interest rates well, but the accuracy is affected by the accuracy of the interest rate model and the prepayment model. According to the characteristics of non-performing assets, Guo Jinchun (2006) designed two ideas for pricing of non-performing asset-backed securities, namely model valuation and empirical valuation[3]. Four pricing methods for non-performing asset-backed securities, including simulated disposal method, factor analysis method, classified pricing method, and extrapolated pricing method, are proposed. Liu Shaobo and Zhang Lin (2006) established an optimal static comparison model to quantitatively analyze the optimal pricing of the credit enhancement rate that maximizes the utility of credit enhancement[4]. Zhang Wenqiang (2009) uses the principle of risk-free arbitrage pricing to construct a pricing model for the three risk factors involved in the securitization of accounts receivable assets, including credit risk, impairment risk, and redemption risk[5].

Up till now, the existing research have laid a solid theoretical foundation for the development of infrastructure asset securitization in my country's real economy, and the pricing of the core parts of securitization has also been involved. However, what is slightly inadequate is that these pricing studies mainly involve securitization products such as real estate and credit assets, but there are few securitization pricing studies that target distribution network infrastructure assets, especially the lack of consideration of distribution network assets. Research on characteristic securitization pricing methods.

3. Basis of power distribution assets of a mall in a city

3.1 General of the electric-power-distribution assets
The assets studied in this article are electric-power-distribution assets shared by a business center and office building in a city’s CBD. The commercial center has an area of 138,000 square meters and an office building area of 39,000 square meters. The occupancy rate of the commercial center is 99%. The occupancy rate is 100%. The power distribution assets have three high-voltage switch stations, namely the commercial center power distribution room, the commercial and office center power distribution room, and the commercial cold source central power distribution room; seven low-voltage power distribution rooms: commercial 1# distribution, commercial 2# distribution, Commercial 3# distribution, commercial 4# distribution, commercial 5# distribution, department store distribution, office building distribution, a monitoring room, a total of 140 power distribution wells on each floor. This part of the distribution asset price information is missing. The distribution assets were purchased before December 2014, and they were transferred to the commercial center company for operation after the investment and construction for another company.

3.2 Analysis of income and cost of the assets

From 2017 to 2019, the total power consumption of commercial centers has gradually increased, with an average annual growth rate of 11%. However, due to the annual decrease in the unit price of power purchase (policy factor), the electricity expenditure is relatively flat, as shown in Table 1:

| Year | 2017 | 2018 | 2019 |
|------|------|------|------|
| Amount (kw·h) | 22535602 | 24810098 | 27576468 |
| Growth rate of Annual usage | / | 10% | 11% |
| Average unit Price | 0.85 | 0.79 | 0.70 |
| Cost (Yuan) | 19199733 | 19686060 | 19393491 |

From the monthly trends (see Table 2), June, July, August, and September are the peak periods of electricity expenditure, followed by October, January and February, and November, December, March, April, and May have lower electricity expenditures, and the most peak electricity bill in August is about 1.9 times that of the trough in November. Taking the electricity consumption in 2019 as an example to analyze the electricity consumption composition, commercial centers accounted for 59%, public electricity accounted for 30%, office buildings accounted for 8%, and transformer losses accounted for 3%.

From the perspective of electricity consumption by tenants of shops and office buildings and the average unit price of electricity sold, although the electricity consumption of shops and office users has increased rapidly, due to the decline in unit price of electricity sold, revenue from electricity sales has decreased in 2019 relative to 2018 (See Table 3), and cannot cover public electricity expenditures (cold source, lighting, elevators, etc.).

| Year | 2017 | 2018 | 2019 |
|------|------|------|------|
| Amount (kw·h) | 22535602 | 24810098 | 27576468 |
| Growth rate of Annual usage | / | 10% | 11% |
| Average unit Price | 0.85 | 0.79 | 0.70 |
| Cost (Yuan) | 19199733 | 19686060 | 19393491 |

| Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. |
|-------|------|------|------|------|-----|------|------|------|------|-----|------|------|
| 2017  | 1354175.6 | 140506.9 | 120528.2 | 116809.7 | 130858.3 | 185058.3 | 218558.3 | 249058.4 | 203906.3 | 189427.4 | 191198.9 | 1375037.4 |
| 2018  | 1470424.8 | 1334534.7 | 1521203.6 | 1285201.6 | 126394.5 | 1887230.4 | 1567420.2 | 3315760.7 | 2024616.5 | 1339762.9 | 1220770.3 | 1419740.3 |
| 2019  | 1616784 | 1609381.8 | 1362232.7 | 1212348 | 1293524.9 | 1861346.3 | 2103017.8 | 2304850.9 | 1950733.4 | 1522562.5 | 1206233.2 | 1350475.5 |

Table 2. Monthly power usage from 2017 to 2019

| Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. |
|-------|------|------|------|------|-----|------|------|------|------|-----|------|------|
| 2017  | 1354175.6 | 140506.9 | 120528.2 | 116809.7 | 130858.3 | 185058.3 | 218558.3 | 249058.4 | 203906.3 | 189427.4 | 191198.9 | 1375037.4 |
| 2018  | 1470424.8 | 1334534.7 | 1521203.6 | 1285201.6 | 126394.5 | 1887230.4 | 1567420.2 | 3315760.7 | 2024616.5 | 1339762.9 | 1220770.3 | 1419740.3 |
| 2019  | 1616784 | 1609381.8 | 1362232.7 | 1212348 | 1293524.9 | 1861346.3 | 2103017.8 | 2304850.9 | 1950733.4 | 1522562.5 | 1206233.2 | 1350475.5 |
Table 4. Power usage and sale in the commercial center from 2017 to 2019

| Year | 2017    | 2018    | 2019    |
|------|---------|---------|---------|
| Average unit price | 1.27    | 1.135   | 0.925   |
| Power usage by shops | 11657060 | 13855448 | 16296956 |
| Power usage by offices | 1327620 | 1937940 | 2121480 |
| Revenue | 16490543.6 | 17925495.38 | 17037053.3 |

3.3 Operational cost of electric-power-distribution assets

The commercial center built at the end of 2014. The power distribution assets are in good condition. Equipment maintenance has not yet occurred. The peak power consumption is less than 60% of the power distribution design capacity. It is expected that the expansion of power distribution equipment is unlikely to occur in the foreseeable future. The maintenance service is not outsourced, and the maintenance is carried out by the self-operated team. Basically, there is no material cost or outsourcing maintenance cost. The largest operation and maintenance expenditure is the operating expenses of the heavy current team (19 people in the heavy current team), followed by the UPS battery replacement cost and the inspection cost, which are estimated to be about 1.82 million per year. The general situation is as follows (Table 5):

Table 5. Composition of the operational cost

| Item                  | Number | Annual Cost | Measure Basis                                                                 |
|-----------------------|--------|-------------|--------------------------------------------------------------------------------|
| Operation staffs      | 19     | 1596000     | Average pre-tax salary 5000 yuan per person                                   |
| Change UPS battery    | 80     | 190000      | 18 batteries in each UPS, each battery is 400 yuan, replace 1/3 of all the batteries every year. |
| Testing fee           | 0.50   | 35000       | The cost of each test is 70,000, and the test is performed every 2 years       |
| Total                 |        | 1821000     |                                                                                |

3.4 Pre-tax cash flow estimation of distribution assets

Before estimating the future cash flow of distribution assets, first of all, some assumptions need to be made: the first assumption is that the public electricity in the commercial center can be recovered at the cost of electricity purchase; at the same time, it is assumed that public electricity occupies 30% of the total electricity. And the loss rate is 3%; secondly, according to the data of the asset in 2017-2019, calculate the power service income generated by the distribution asset in the past three years. The annual electricity purchase amount is calculated by the product of the annual electricity purchase and the electricity purchase unit price. The annual electricity sale is equal to the annual electricity purchase minus the electricity loss, and the annual electricity sale is multiplied by the electricity unit price to get the annual electricity sale amount. The pre-tax annual net cash flow of distribution assets can be derived by the following formula (1):

\[
NCF = Revenue - cost_{\text{purchase}} - oper
\]

In which, \(NCF\) is the annual net cash-flow of the distribution assets; \(Revenue\) is the revenue from the sale of the electricity; \(Cost\) is the annual cost of purchasing electricity; \(Oper\) is the operational cost of the distribution assets.

Assuming that the operating expense ratio of power distribution assets \((100\% \times \text{operating...})\)
expenses/revenue from electricity sales) is 7%, office buildings and shops are billed according to the average unit price of electricity sold. Substituting relevant data into Equation 1, you can get 2017 - The pre-tax net cash flow of distribution assets of a commercial center in a city in 2019 (Table 6). It is expected that the price of electricity sold and the price of electricity purchase will stabilize. Therefore, in this article, we use the net profit before tax of the target commercial center in 2019 as the net cash flow of distribution assets before tax, in accordance with the "New Corporate Income Tax Law Implementation Regulations", where article No.60 stipulates that the depreciation period of power distribution assets is 10 years. As of 2019, the power distribution assets of the commercial center described in this article have been used for 5 years. Therefore, when estimating the future cash flow of power distribution assets, 5 years are used. As the remaining service life of the distribution assets of this commercial center.

4. Valuation models and results
In order to valuate the future return rate of distribution assets, this paper uses three methods to price it, namely, the static cash flow rate of return method [1], the dynamic spread method, and the scenario analysis method.

Table 6. Pre-tax cash-flow of distribution assets from 2017 to 2019

| Year | 2017       | 2018       | 2019       |
|------|------------|------------|------------|
| Power purchased (kw·h) | 22535602   | 24810098   | 27576468   |
| Power sales (kw·h)    | 22084890   | 24313896   | 27024939   |
| Unit price of purchase(yuan/kw·h) | 0.85       | 0.79       | 0.7        |
| Unit price of sale(yuan/kw·h) | 1.27       | 1.135      | 0.925      |
| Revenue(yuan)         | 24423679.85| 24251895.57| 22423943.14|
| Cost (yuan)           | 19199733.36| 19686060.44| 19393491.03|
| Margin(yuan)          | 5223946.491| 4565835.125| 3030452.105|
| Operational Cost(yuan)| 1709657.59 | 1697632.69 | 1569676.019|
| Pre-tax profit(yuan)  | 3514288.901| 2868202.436| 1460776.086|

4.1 Static cash-flow return rate model
The underlying principle of this method is to first determine a risk-adjusted necessary rate of return, and then discount the expected future cash flow using the rate of return of disposal to the base period, as shown in (2).

\[ p = \sum_{t=1}^{5} \frac{CF_t}{(1+r)^t} \]  

Where, \( P \) represents the price of the electric-power distribution assets backed securities; \( CF_t \) is the cash-flow generated by distribution assets in period \( t \); \( r \) is the necessary return rate adjusted by risk. For the commercial center electric-power-distribution assets studied in this paper, because the future cash flow uniformly adopts the net cash flow before tax in 2019, the key to pricing is to determine the appropriate necessary rate of return. Some domestic companies have publicly issued asset-backed securities on the Shanghai Stock Exchange in recent years[6]. When determining the necessary return on the distribution network assets studied in this article, the author refers to the basis of the above-mentioned publicly issued asset-backed securities' yield to maturity After comprehensively considering the credit risk of the distribution network assets, the characteristics of the distribution assets, and the
comprehensive situation of the issuing company, the necessary rate of return on the distribution network assets is set to be 6.5%.

4.2 Dynamic spread method
The dynamic spread method is based on the nominal spread method, and its key is to determine the benchmark risk-free yield curve. The dynamic spread method assumes that the multiple between the yield curve of a specific credit rating and the benchmark yield curve is stable, that is, the quotient between the two at any two time points is constant at m. The pricing of the zero-volatility spread method is shown in (3):

\[ p = \sum \frac{CF_t}{(1+r_t*m)^t} \]  

(3)

\( CF_t \) is the cash flow in the t-th period of the level of security under the general market assumptions, and \( r_t \) is the risk-free rate of in period t. According to the practice of the US market, institutional asset-backed securities generally includes the government’s credit, so the bond yield curve often was adopted as benchmark, while non-institutional asset-backed securities generally adopt a more market-oriented risk-free yield curve, such as an interest rate swap curve. As a benchmark, carry out asset-backed securities pricing. The dynamic spread method takes into account the term structure of interest rates. According to the Haitong Securities Credit Bond Research Report, on average, the yield to maturity of asset-backed securities is 2.2 times the yield to maturity of treasury bonds with the same maturity and the same grade[7]. In this paper, the national debt yield curve on February 8, 2021 is used as the risk-free interest rate of the corresponding maturity (see Figure 1).

\[ \text{Source: Central Government Securities Depository and Clearing Corporation} \]

**Figure 1.** Treasure Bond Yield curve

4.3 Scenario analysis
Scenario analysis is a method used to analyze the dynamic nature of asset-backed securities. It can complement the static cash flow rate of return method[8]. This method calculates the holding period return rate of asset-backed securities under various possible future scenarios. In each case, the cash flow of asset-backed securities comes from the future income brought by the underlying assets. Considering the return status of the initial investment during the entire holding period, a set of asset values consistent with the number of scenarios can be obtained, and the present value of future returns of distribution assets can be calculated by weighted summation[9].

In this study, we use three scenarios for analysis, namely (1) operation and maintenance expense rate is 7%; (2) operation and maintenance expense rate is 5%; (3) operation and maintenance expense rate is 2%. Based on previous professional experience in this area, we set the weights of the three scenarios to
1/4, 1/2, and 1/4 in turn. According to the calculation method in Table 6, the net profit before tax in 2019 under the above three scenarios is calculated (see Table 7).

| Scenario 1   | Scenario 2   | Scenario 3   |
|--------------|--------------|--------------|
| 1460776.09   | 1909254.9    | 2581973.2    |

4.4. Results analysis

Using the above three methods to estimate the future income of the commercial center distribution network assets studied in this paper, the results are summarized in Table 8:

| Static cash-flow return rate | Dynamic spread | Scenario analysis |
|-----------------------------|----------------|-------------------|
| 6,070,517.14                | 6,069,254.02   | 8,167,218.33      |

From the pricing results, the difference between the static cash flow rate of return method and the dynamic spread method is relatively small, while the exchange asset value calculated by the scenario analysis method is different from the previous two methods. The main reason is that the absolute value of the cash flow in each period of the first two methods is similar, and the discount rate does not change much; on the contrary, under the scenario analysis method, the degree of difference in cash flow under different O&M expense ratio scenarios is for 5% and the 2% operation and maintenance expense ratio scenario corresponds to a higher weight (75% in total). Compared with the first two methods, the annual net cash flow calculated at the 7% operation and maintenance expense ratio is higher than the error. This leads to the fact that in practice, if the determined scenario is consistent with the actual situation earlier, and the pricing results obtained by the scenario analysis method will be able to achieve the results obtained by the first two methods. For ease of use, the first two methods have more advantages.

5. Conclusion

As an important part of infrastructure asset, electric-power-distribution-network assets can generate stable cash flow and are very suitable for building a basic asset pool for asset securitization. However, the cash flow of distribution network assets is affected by many factors, such as the level of economic development in the area where the distribution assets are located, the nature of the objects served by the distribution assets (such as the commercial center in this article), the local climate, and the status of the distribution assets. Operation and maintenance expense rate, etc., these factors will have a greater impact on the future cash flow of distribution assets, and there are still large differences in the impact of these factors on different distribution assets, but for the future cash flow of distribution network assets, there is little research on the evaluation method of the company, and research in this field can be carried out in the future to explore the prediction model of the future cash flow of the distribution network assets with strong applicability. When determining the appropriate discount rate for the pricing of the distribution network asset-backed securities, the static cash flow rate of return method and the dynamic spread method can be used for reference to determine a discount rate, and the static cash flow rate of return method is used for this model. Valuation is more feasible in practice, because this model has fewer parameters than the other two models, which can reduce the large deviation of the results caused by the small deviation of the parameters. Moreover, the static cash flow rate of return method is easy to use and its logic is stronger.

6. References

[1] Xu Dong. Pricing method of infrastructural assets securitization[J]. Journal of City rail transit, 2006(9).
[2] Xie Yue. Discussion on REITs Model of Asset Securitization of Toll Expressway [J]. China International Finance and economics, 2018.

[3] Guo Jinchun. Research on the Pricing of Non-performing Asset-backed Securities[J]. http://epub.cnki.net/, 2006.

[4] Liu Shaobo, Zhang Lin. Credit enhancement and pricing issues in financial innovation[J]. Journal of Financial Research, 2006(3).

[5] Zhang Wenqiang. On the Risk Pricing of the Asset Securitization of Accounts Receivable in Entity Enterprises[J]. Journal of Financial Research, 2009(5).

[6] Wang Yu. Research on the use of infrastructure REITs financing by highway enterprises[J]. Journal of Modern economic information, 2019.

[7] Yang Bo. On the Rise and Practice of Public Funding Infrastructure REITs in China[J]. Journal of Technology Think Tank, 2020(4).

[8] Li Dongyue, Wang Xiaoyun. An Empirical Analysis of REITs Pricing——Taking "Darong City REITs" as an Example[J]. Journal of Fireworks Technology and Market, 2020(2).

[9] Yan Yan, Gu Yalu, Zhu Xiaowu. Research on the Issue of Asset Securitization of Expressway Earning Rights[J]. Journal of Financial Research, 2016(5).