A Research on Neoinfrastructure REITs Pricing Measures and Risk Management

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Abstract. Since China's neoinfrastructure REITs have just started, there is limited research on REITs products and risks in China. This paper analyzes the revenue and risk characteristics of infrastructure such as small hydropower stations and modifies the traditional operating cash flow method, multiplier method, and other REITs product pricing methods to make them applicable to small hydropower stations REITs product pricing. At the same time, this paper carries out a sensitivity analysis of the key factors affecting the value of infrastructure to provide a reference for the risk management practices of neoinfrastructure REITs products.

Keywords: Reits · Risk Management · Pricing Model · Cash Flow from Operation · Multiplier

1 Introduction

Infrastructure is an essential guarantee for the country's economic development, and the improvement of infrastructure has played an important role in the rapid development of China's economy in recent decades. China's economic development has shifted from high-speed development phrase to high-quality development phrase. Some problems have been exposed during the transition. At the same time, the unexpected epidemic has caused a significant impact on the domestic and global economy. China is facing a complex domestic and foreign macroeconomic atmosphere and superimposed problems such as fluctuation and slower economic growth. In this context, the central government puts forward the strategic concept of the double cycle. In order to further promote financial services to the real economy and revitalize the huge stock of infrastructural assets, on April 30, 2020, the China Securities Regulatory Commission and the National Development and Reform Commission jointly issued the "Regarding the Promotion of the Pilot Work of Real Estate Investment Trust Funds (REITs) in the Infrastructure Sector" Notice." In the issuance of neoinfrastructure real estate investment trust funds and the investment decision-making process of investors, the pricing or valuation of target real estate investment trust funds is indispensable. Therefore, it is necessary to research the pricing or valuation methods, risk management, and control of such asset trust investment funds based on the characteristics of revenue and risks of such neoinfrastructure. This article is divided into four parts. The first part is the introduction, which briefly

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introduces the background and purpose of the research; the second part summarizes domestic and foreign research with the research results of domestic and foreign scholars in this field; the third part is the theoretical fundamentals. It introduces the major methods of pricing or valuation of new infrastructure trust investment funds and the main risk factors; the fourth part adopts the third part of the method, taking the small hydropower asset REITs as an example for empirical research; the fifth part is the conclusion.

2 Literature Review

Domestic and foreign scholars have been studying REITs pricing and risk management and have formed relatively abundant research results. However, these studies mainly focused on REITs with real estate assets as the underlying assets but did not research much about REITs with real estate like neoinfrastructure as the underlying assets. In some existed studies, Dong Qi (2020) believes that there is often only one infrastructure project in certain area, and it is not easy to find comparable projects; moreover, the value of infrastructure assets has the characteristic of diminishing over time. Therefore, the DCF method commonly used in real estate REITs and the comparable project valuation method used in valuation are not very applicable in the valuation of infrastructure projects [2]. Zhou (2013) predicts Beta through a state-space model, such as capital budgeting involving REITs to estimate the cost of capital and determine the pricing of equity REITs. When it comes to price publicly offered REITs, some scholars believe that the valuation of primary assets can be used as an anchor for investors to pricing REITs [7]. In addition, according to the "Operational Guidelines for Publicly Offered Infrastructure Securities Investment Funds (Trial) (Draft for Comment)," The discounted cash flow method in the income method should be used as the primary evaluation method. It can be seen that the anchor of public REITs pricing is mainly based on the estimated value of assets determined by future cash flows and discount rates [1]. For the parameter of determining the discount rate of assets, Harry Markowitz proposed the famous capital asset pricing model (CAPM). It combines the return rate, variance, risk-free interest rate of the target asset with the return rate, variance, and risk-free interest rate of the market portfolio [4]. This construction of a quantitative model provides a scientific calculation method for the pricing of risky assets. When it comes to the risks of REITs, Yang Linni (2020) analyzed the liquidity risk, operating risk, and investment risk of Yuexiu REITs. He pointed out that financial leverage can be adjusted to the comprehensive capital cost to reduce liquidity risk [5]; management costs can be reduced to increase profits and reduce the profit risk and business risk of the enterprise; carefully selecting assets and strengthening the supervision of the use of funds can reduce investment risk. Zhang Jiarong (2019) and others believe that the main risk categories of REITs are macroeconomic risks, political and policy risks, primary assets and financial risks, originator risks, and risks related to transaction and product design [6]. In contrast, domestic REITs research started relatively late, and most of them are limited to the discussion of their origin, concept, importance, and fund model. Although they have achieved some results, the topic of pricing and risk management of new infrastructure REITs still needs to be explored more.

3 Theoretical Fundamentals

REITs is the abbreviation of Real Estate Investment Trust, also known as real estate investment trusts. They collect funds through the issuance of stocks managed by a particular fund custodian, entrust a particular investment institution to manage real estate investment, and distribute the comprehensive income of investment to investors in proportion [6]. From an international perspective, REITs are a type of trust fund that pools the funds of a specific majority of investors by issuing income certificates, is managed by a particular investment institution for real estate investment, and distributes the comprehensive income of the investment to investors in proportion. In essence, REITs are a method of asset securitization, which have the characteristics of high liquidity, relatively stable returns, and strong security. Most countries provide tax support policies for REITs products. However, depending on the source of income, REITs can be divided into equity type and mortgage type.

The essence of equity REITs is equity financing, which involves real transactions of underlying assets; that is, real-estate will be transferred from one party to another. Based on the real estate acquired by the exchange, the buyer adopts a specific transaction structure and issues asset income securities for financing. Equity REITs make profits by the revenue from the underlying assets and capital gains. This category of REITs is the research object of this article.

Mortgage REITs will use raised funds as a financial intermediary to earn interest through loans or mortages to real estate developers and operators, and sometimes purchase real estate loans or real estate mortgage-benefit securities from other banks, and put them in the portfolio to lend to real estate to developer or assets operator.

3.1 Major Pricing Models of REITs

In the enterprise value evaluation system, the basic evaluation methods that we are familiar with include cost method, income method, and market method. There are many different evolutions of these three methods for different enterprises and asset types. For REITs, these three basic methods have also evolved correspondingly. REITs valuation methods mainly include discounted operating cash flow method and the P/FFO multiplier method.

3.1.1 Discounted Cashflow from Operation

The Discounted Cashflow from Operation, evolved from the discounted cash flow method. The valuation method is to build a financial model based on certain assumptions on the operating cash flow generated by the real estate, discount the sum of the real estate's subsequent cash flows, and predict the estimated amount at the end of the period. In corporate valuation, net income defined by generally accepted accounting principles (GAAP) is generally used as the primary operating performance evaluation standard. However, this indicator is not suitable for REITs because the net income has not been adjusted for depreciation. When calculating the net income of an enterprise, depreciation expenses are deduction items, but for infrastructure real estate, most real estate will maintain and increase in value due to its sound operation and maintenance

[3]. The substantial depreciation expenses in accounting treatment are used to calculate the value of REITs. At times, it is easy to cause underestimation.

In 1991, the value of FFO (funds from operations, working capital) was introduced by the American NAREIT organization as a supplemental measure to evaluate the operational performance of REITs. The FFO in this definition is still based on the net income defined by GAAP, on which depreciation expenses are added back, and some related capital gains (if any) are adjusted to obtain the FFO indicator, thereby using FFO to measure the value of REITs. When calculating the FFO indicator, taking into account the consistency of the adjustment caliber of the net income, it is necessary to subtract the capital gains from the sale of the property. Because capital gains are obtained when properties are sold at a price higher than the holding cost, and depreciation directly affects the holding cost, so in order to be consistent, the corresponding capital gains must be subtracted.

Nevertheless, FFO is not currently a standardized indicator, and there is no official organization that defines FFO to give a concept of net income. REITs still lack consistency in reporting FFO. However, FFO provides clearcut guidance for evaluating the REITs.

Green Street Consulting, a leading US REITs research institute, proposed the concept of AFFO (Adjusted Working Capital) to improve the FFO method. The adjusted working capital is to adjust those expenses that have been capitalized but did not increase the real estate value based on working capital. In addition, the net income defined by GAAP is usually obtained after straight-line amortization or deduced by balancing operating income during the operating period. However, in actual operation, the operating income for many years is not smooth. Considering this factor, when calculating FFO, some institutions usually adjust their income to reflect the actual operating income during the reporting period.

When determining AFFO, researchers will look at the actual capital expenditures undertaken by REITs during the reporting period, while others use long-term mean values to smooth out exceptionally high or low capital expenditures. Some scholars have tried to determine a "routine" value based on the historical experience of REITs over the years.

Theoretically, although AFFO can better measure the free cash flow of REITs, considering the difficulty and universal applicability of information acquisition; practically, we still use the more common FFO indicator as the benchmark to measure the value of REITs, rather than AFFO indicator.

The difficulty of the discounted operating cash flow method original from the complexity in determing the discount rate in the popular DCF model. The determination of the discount rate will be relatively subjective. In general, the methods for determining the discount rate include four mainstream calculation methods: the capital asset pricing model (CAPM), the weighted average cost of capital model, the risk accumulation method, and the average industry rate of return method. There are generally two methods for determining the discount rate of REITs valuation in the US REITs market. One is the average adjustment method; in the REITs portfolio, the average capitalization rate of real estate is determined, and the debt leverage used by REITs is adjusted. The average rate of return of the real estate in the REITs portfolio is obtained, and the financial leverage

of REITs is adjusted to get the discount rate. The other method is the expert experience method; that is, experts in the REITs industry evaluate the risks of specific REITs to obtain the necessary rate of return that we expect to obtain to bear the risk, and use this as the discount rate of REITs.

The formula for calculating the indicators related to the valuation of REITs is as follows:

$$V = \sum_{i=1}^{n} \frac{FFO_i}{(1+r)^i} \tag{1}$$

where V is the appraised value of the property, and FFOi is the operating cash flow of the i period of the property.

$$WACC = KD \times \frac{TD}{V} + KE \times \frac{E}{V} \times (1 - T_c) \tag{2}$$

Among them, KD is the cost of debt capital; KE is the cost of equity capital; TD is the total debt capital; Tc is the tax rate.

Net income = all income (including capital gains)-operating expenses, write-offs, depreciation, amortization, interest expenses, and general administrative expenses.

FFO = net income-capital gains from property sales + property depreciation expenses.

AFFO = FFO-normal and frequently incurred capital expenditures and adjustments to gains or losses on debt repaid in advance.

3.1.2 P/FFO Multiplier

The P/FFO multiplier valuation model is similar to the pe multiplier model in general corporate value evaluation. The multiplier valuation model is used very frequently in mature Western markets, especially when investment banks use it to value companies. When using the P/AFFO multiplier method for valuation, we consider REITs as a whole market, and we choose a lower or higher multiplier based on market conditions.

The formula of the P/FFO multiplier valuation model is as follows:

$$V = FFO \times \left(\frac{P}{FFO}\right) \tag{3}$$

Or

$$V = AFFO \times \left(\frac{P}{AFFO}\right) \tag{4}$$

Among them, $\frac{P}{FFO}$, $\frac{P}{AFFO}$ in Eq. 3 and Eq. 4 are the multipliers of comparable REITs, respectively.

3.2 Risk Elements

Many risks affect REITs, including macroeconomic risks, policy risks, primary assets and financial risks, originator risks, risks related to transactions, and product design.

However, this article is limited to discussing underlying asset returns and interest rate risks.

Fundamental asset returns and interest rate risks are mainly divided into property rights and regulatory risks, financial risks, cash flow, and valuation risks. The underlying assets included in the underlying assets are the basis for the value of REITs and the source of operating cash flow (FFO). Its operational stability and profitability directly determine the performance and competitiveness of REITs and are the most critical risk factors affecting REITs investment. Regarding property rights and regulatory risks, whether it is overseas REITs or domestic REITs, REITs are the basis for exercise ownership or mortgage rights and other real rights over the invested assets. In order to effectively increase the level of securities dividends, domestic REITs have introduced financial leverage standards within the allowable range. Like general corporate finance, the financial leverage of REITs is also a double-edged sword, so it must strictly follow the customary asset-liability ratio to keep it within a reasonable range and accurately grasp the trend of interest rates and debt schedules. If not, it may lead to liquidity bankruptcy or liquidation.

4 Empirical Study: Take Small Hydropower Plants as Examples

Small hydropower plant, as the name suggests, refers to a small hydraulic power plant. Different countries have their own definitions of small hydropower. In China we define *small hydropower* as hydropower plants with an installed capacity of 25,000 kW or less and supporting local power grids funded and managed by local, collective, or individual funds. Small hydropower assets have mature business models and market-oriented operation capabilities, which can generate continuous and stable income and cash flow. The investment recovery period is long, but the return on investment is sound. Therefore, infrastructure facilities such as small hydropower stations are very suitable as the primary assets of REITs. This paper takes small hydropower assets as the research object and conducts an empirical analysis of REITs' pricing and risks.

The primary assets of the REITs studied in this article are all distributed in the Minjiang River, Dadu River Basin, and its tributaries. The asset group includes six small hydropower stations (see Table 1 for details). When assessing the future return of assets, it is assumed that the power generation of each small hydropower station in the next 5 years is the average value of the power generation in the past 5 years, the comprehensive power consumption rate is 0.72%, and the operation and maintenance expense rate is 40% (then daily 3% increase), the on-grid electricity price is 0.288 yuan/KW·H. In this part, we use the discounted operating cash flow method and the P/FFO multiplier method to price the target assets.

4.1 Pricing Results by DCF

Based on the assumptions above, it is not difficult to get the calculation method for calculating the operating cash flow of the power station:

$$CFFO = Generated\ energy \times 1 - consumption\ ratio \times Unit\ price - operational\ cost \tag{5}$$

$$operational\ cost = mantainance\ cost\ of\ equipment\ and\ factories + human\ cost + other\ cost \quad (6)$$

The results of data sorting and pricing are shown in Table 1.

Table 1. Value of small hydropower assets backed REITs based on DCFFO

		Energy generated (10^4kWh)	Unit Price (Yuan)	Revenue (10^4Yuan)	Operational Cost (10^4Yuan)	NCF (10^4Yuan)	PV of NCF (10^4Yuan)
Plant A	2020	1010.66	0.288	288.97	115.59	173.38	
	2021	1010.66	0.288	288.97	115.59	173.38	163.57
	2022	1010.66	0.288	288.97	124.26	164.71	146.59
	2023	1010.66	0.288	288.97	132.93	156.04	131.02
	2024	1010.66	0.288	288.97	141.60	147.37	116.73
	2025	1010.66	0.288	288.97	150.26	138.71	103.65
	subtotal						661.56
Plant B	2020	1398.55	0.288	399.88	159.95	239.93	
	2021	1398.55	0.288	399.88	159.95	239.93	226.35
	2022	1398.55	0.288	399.88	171.95	227.93	202.86
	2023	1398.55	0.288	399.88	183.94	215.94	181.30
	2024	1398.55	0.288	399.88	195.94	203.94	161.54
	2025	1398.55	0.288	399.88	207.94	191.94	143.43
	subtotal						915.48
Plant C	2020	1221.62	0.288	349.29	139.72	209.57	
	2021	1221.62	0.288	349.29	139.72	209.57	197.71
	2022	1221.62	0.288	349.29	150.19	199.10	177.19
	2023	1221.62	0.288	349.29	160.67	188.62	158.37
	2024	1221.62	0.288	349.29	171.15	178.14	141.10
	2025	1221.62	0.288	349.29	181.63	167.66	125.28
	subtotal						799.66
Plant D	2020	502.82	0.288	143.77	57.51	86.26	
	2021	502.82	0.288	143.77	57.51	86.26	81.38
	2022	502.82	0.288	143.77	61.82	81.95	72.93
	2023	502.82	0.288	143.77	66.13	77.64	65.18
	2024	502.82	0.288	143.77	70.45	73.32	58.08
	2025	502.82	0.288	143.77	74.76	69.01	51.57
	subtotal						329.14

(*continued*)

Table 1. (*continued*)

		Energy generated (10^4kWh)	Unit Price (Yuan)	Revenue (10^4Yuan)	Operational Cost (10^4Yuan)	NCF (10^4Yuan)	PV of NCF (10^4Yuan)
Plant E	2020	12980.70	0.288	3711.52	1484.61	2226.91	
	2021	12980.70	0.288	3711.52	1484.61	2226.91	2100.86
	2022	12980.70	0.288	3711.52	1595.95	2115.57	1882.85
	2023	12980.70	0.288	3711.52	1707.30	2004.22	1682.78
	2024	12980.70	0.288	3711.52	1818.64	1892.88	1499.33
	2025	12980.70	0.288	3711.52	1929.99	1781.53	1331.26
	subtotal						8497.09
Plant F	2020	2813.00	0.288	804.31	321.72	482.59	
	2021	2813.00	0.288	804.31	321.72	482.59	455.27
	2022	2813.00	0.288	804.31	345.85	458.46	408.02
	2023	2813.00	0.288	804.31	369.98	434.33	364.67
	2024	2813.00	0.288	804.31	394.11	410.20	324.92
	2025	2813.00	0.288	804.31	418.24	386.07	288.49
	subtotal						1841.37
Total							13044.30

4.2 Valuation Results by P/FFO Multiplier

The capital structure of the small hydropower plants involved in this study is simple and has no liabilities. Therefore, there is no need to adjust the operating cash flow FFO. In the valuation, the net operating cash flow in 2020 will be directly used as the basis for the pricing process. According to the Wind (a financial database provider) primary industry classification, the assets of small hydropower stations belong to the public utility infrastructure. According to previous scholars' research on the US REITs market, the average P/FFO multiplier of equity infrastructure REITs listed on the US stock market is 11.7. Therefore, in the research of this article, we assume that the reasonable multiplier is 11.7, and the valuation results are summarized in Table 2.

4.3 Pricing Results and Risk Analysis

4.3.1 Analysis of Results Difference

From the results derived by the two pricing methods, it can be seen that the results obtained by the two methods are pretty different. The main reasons are as follows: (1) When using the discounted operating cash flow (DCFFO) method, we assume that the operation and maintenance expenditure is based on an annual basis. A 3% increase is used to calculate the net operating cash flow during the forecast period. However, when

Table 2. Value of small hydropower assets backed REITs based on P/FFO multiplier

	Energy generated (10^4kWh)	Unit Price (Yuan)	Revenue (10^4Yuan)	Operational Cost (10^4Yuan)	NCF (10^4Yuan)	P/FFO	Value by Multiplier (10^4Yuan)
Plant A	1010.66	0.288	288.97	115.59	173.38	11.7	2028.57
Plant B	1398.55	0.288	399.88	159.95	239.93		2807.16
Plant C	1221.62	0.288	349.29	139.72	209.57		2452.02
Plant D	502.82	0.288	143.77	57.51	86.26		1009.27
Plant E	12980.70	0.288	3711.52	1484.61	2226.91		26054.87
Plant F	2813.00	0.288	804.31	321.72	482.59		5646.26
Total							39998.13

the multiplier method is used for valuation, the net operating cash flow is calculated based on the 2016–2020 operation and maintenance costs. This method will overestimate the net operating cash flow FFO compared with the discounted operating cash flow method. (2) The selected multiplier is too large. Among the equity-based REITs currently publicly listed at home and abroad, there is no REIT product with hydropower plant assets as the primary asset. Therefore, there is no comparable product that is consistent with the nature of the subject of this paper. Therefore, we only look for assets similar to the property of the small hydropower station's asset income and risk and directly use the multiplier of the similar asset or the value of the multiplier after appropriate adjustments. From Wande's industry classification perspective, small hydropower belongs to the infrastructure industry, which is the basis for using the multiplier mentioned above in this study. However, according to the income characteristics of the assets of small hydropower stations, once the construction of such assets as small hydropower stations is completed, the upper limit of their power generation has been determined, and their income will mainly depend on the future power generation and on-grid electricity prices. From this perspective, small hydropower stations' profit model is similar to that of the hotels but differs from highways and other infrastructure. The average multiplier of REITs for equity-listed hotels in the United States is 7.7. If this value is substituted, the above-mentioned small hydropower portfolio REITs value will be 263 million, which significantly converged to the valuation result of the discounted cash flow method.

4.3.2 Risk Factors Analysis

There are many influencing factors of the asset price of small hydropower plants described in this article, but the essential influencing factor is the future operating cash

Table 3. Sensitivity analysis of main factors

	Benchmark	Unit Price		Discount Rate		Growth rate of operational cost	
Scenario		−10%	10%	−1%	1%	−1%	1%
Net value of portfolio	13044.3	11739.88	14348.77	13392.99	12710.05	13496.39	12592.21
Change(%)		−10.00%	10.00%	2.67%	−2.56%	3.47%	−3.47%

flow of the asset. This article mainly discusses the risks brought by changes in future operating cash flow. Power generation, on-grid power price, and total plant power consumption rate are the three main factors of the power generation revenue, and the power generation revenue determines a hydropower station's future cash flow inflow. The operating cash flow outflow is composed of plant and equipment overhaul expenses, labor costs, and other expenses related to operation and maintenance expenditure. In addition, changes in policies may also lead to changes in the cash flow of power stations, but this factor is weak in predictability, so it is not discussed in this article. We focus on analyzing the risks on the portfolio's value from the changes in three factors: feed-in tariff, operating expense growth rate, and discount rate. In this paper, sensitivity analysis is used to measure the impact of on-grid electricity prices, operating expense growth rates, and discount rates on the value of asset portfolios. The specific method is that on-grid electricity prices fluctuate by 10% and −10% respectively; operating expense growth rates are respectively Change of 1%, −1%; discount rate of 1%, −1%; analysis, calculation, and settlement are shown in Table 3.

From the calculation results of sensitivity analysis, it can be seen that the on-grid electricity price has a positive linear correlation with the value of the asset portfolio. In contrast, the discount rate and the growth rate of operation and maintenance expenses negatively correlate with the asset portfolio's value. The combination value on discount rate and operation and maintenance expenditure shows greater sensitivity from its cost growth rate.

5 Conclusion

When pricing new infrastructure REITs, no matter what method is adopted, the future cash flow of the underlying asset portfolio should be scientifically and reasonably predicted. When using the discounted operating cash flow method, choosing an appropriate discount rate is also essential. The discount rate includes the risk premium of the underlying asset portfolio. The identification and in-depth study of key risk factors are the core of the new infrastructure REITs; when the multiplier method is used for pricing, in addition to the agreement between future cash flow prediction of the underlying asset portfolio and the reality, it is also vital to select the corresponding multipliers of publicly listed REITs that are similar to the underlying assets. Because the value of the asset portfolio and the corresponding REITs products are highly dependent on the future cash

flow of the underlying assets, in the case of the small hydropower station in this article, the determinants of the future cash flow of the hydropower station are the on-grid electricity price and power generation. The on-grid electricity price and the overall economic development and changes in energy efficiency are closely related, and the amount of power generation depends largely on the rainfall in the basin where the power station is located. This can be more accurately predicted by studying the historical hydrological data of the basin. On the one hand, the discount rate is affected by the term structure of interest rates in the capital market; on the other hand, it is related to the overall risk appetite of the market. When pricing and investing in new infrastructure REITs, risk factors from these aspects should be fully considered, and in-depth research should be conducted in these areas in the future.

References

1. China Securities Co. Ltd research team. (2021) International experience and reference of infrastructure REITs' development. Securities Market Herald, no 1
2. Dong Q (2020) Product key elements of infrastruacture REITs. China Financ (11)
3. Li M et al (2017) Guidelines for China in the valuation of Quasi-REIT assets. J Financ Mark Res (07)
4. Li N, Xu Q et al (2019) A Comparative Study of REITs models in domestic and oversea. Constr Econ (2)
5. Yang L (2020) A study of financial risk of YueXiu REITs. HeBei Enterp (3)
6. Zhang J, Guo L (2019) Analysis of REITs financing risk factors in China. Mod Mark (07)
7. Zhou J (2013) Conditional market beta for REITs: A comparison of modeling techniques. Econ Model 30(30)