Research on Investment Valuation of New Energy Projects based on Real Option Model

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Abstract: Based on the real option theory, this paper identifies the option characteristics of the new energy project investment, establishes the B-S option pricing model of the new energy project investment, and evaluates the investment value by empirical analysis. The study finds that the real option approach considers the uncertainty in the new energy project investment, and it can better evaluate the decision value of new energy projects.

Keywords: real option, new energy, investment valuation, B-S model

1. Introduction

With the increasing demand for energy, the decreasing of conventional energy storage and the increasing environmental pollution, the development and utilization of new energy has become an important measure to improve the environmental pollution and optimize the energy structure. New energy, also known as a non-conventional energy, refers to renewable energy developed on the basis of new technology, including solar energy, wind energy, biomass energy, geothermal energy, tidal energy and other energy forms.

As the new energy industry has the characteristics of high cost, high risk and positive externality, the government has issued a series of supporting policies, including financial subsidies and tax incentives to promote the development of the new energy industry. However, the new energy industry is a strategic new industry. It has not yet owned advanced technology level and mature market system. It is easily influenced by the factors such as the economic environment, industrial policy and the supply and demand of the energy market. All the influence factors have great uncertainty. Therefore, a scientific and reasonable investment decision-making method is urgently needed to evaluate the investment of new energy projects.

2. Literature Review and Theoretical Basis

The traditional investment project value evaluation theory, which bases on discounted cash flow, holds that investors must make investment decisions at a certain point of time, without considering the active decision of the managers, the possibility of future investment profit, and the constant change of the internal and external environment of the project (Zhang Mingming, 2014). At present, the traditional method based on net present value theory cannot deal with the uncertainty of investment in new energy projects. The high discount rate is usually used to reflect the uncertainty of the project, which leads to the undervaluation of the investment and restricts the enthusiasm of investors to invest in the project (LiWei, 2012

) . Therefore, there are many inherent defects in the traditional investment decision-making method, which can not make a scientific and accurate evaluation of the investment in this field.

Real option is the extension of the modern financial option pricing theory in the field of real investment decision. It is an investment decision tool to consider the future possibility of the project as an investment opportunity. The earliest real option theory originates from Myers (1977). Therefore, scholars have gradually applied the real option method to the research of the new energy industry. Li Qing (2016) established the real option model of wind electricity price policy, and theoretically demonstrated the relationship between the optimal investment price of wind power and the fluctuation rate of the price. Gong Piqing (2017) used trigeminal tree model of real option method to calculate the net present value and the real option value of the renewable energy project investment under the influence of the uncertainty of the carbon price fluctuation. Xiao Ying (2017) used real option pricing method to evaluate the value of pure electric vehicle, and concluded that real option method can reflect the value of pure electric vehicle R & D project more than NPV method.

In conclusion, this paper analyzes the options characteristics of new energy projects and establishes a B-S option investment decision model, which can be used to quantitatively analyze the investment value of new energy projects, and provide a more reasonable idea for investors to evaluate the value of new energy decision-making with uncertain factors.

3. New Energy Projects Investment's Option Features Analysis and Model Construction

3.1 Analysis of option features of new energy project investment

The use of real option method to analyze investment value requires that new energy projects have basic options characteristics: uncertainty, irreversibility and flexibility.

Firstly, the investment income of new energy projects has great uncertainty, because the new energy industry is easily affected by the economic environment, the government subsidy policy, the electricity market price, the new energy generation technology level and other factors. Secondly, the investment of new energy projects is generally the construction of photovoltaic and wind power stations, and the

DOI: 10.21275/ART2019285

proportion of fixed assets investment is relatively large, making investment irreversible. Then, after the initial investment, the new energy project can adjust the investment quota and investment time according to the information obtained in the future, which makes it flexible,

Therefore, we can see that the new energy project investment has the basic characteristics of the option, and its investment decision-making process is equivalent to the execution process of call option. After the initial investment, if the new energy market environment is good or the project is expected to bring considerable benefits, we can choose to continue the additional investment to promote the construction of the project, expand the scale of the project and gain higher income. On the contrary, if the market situation is worse or less than expected, it is not necessary to make an immediate decision on whether to invest or not, to choose the appropriate investment time within the period of the project approval construction.

3.2 The option model construction of new energy project investment

Based on this, the investment process of new energy projects can be regarded as European real call option. We use Black-Scholes option pricing theory to evaluate and analyze the value of new energy projects. The formula is as follows:

$$C = S(t)N(d_1) - Ke^{-r_f(T-t)}N(d_2)$$
(1)

 $N \bigcirc$ is the cumulative normal distribution function,

$$d_{1} = \frac{\ln(s(t)/K) + (r_{f} + \sigma^{2}/2)(T-t)}{\sigma\sqrt{T-t}}$$
(2)

$$d_2 = d_1 - \sigma \sqrt{T - t} \tag{3}$$

Among them, the variable definitions in the B-S option pricing model are as follows:

Variable name	Real options	Variable definitions		
S	the expected future price of the asset	the present value of investment income of new energy projects		
К	the future cost of acquiring the asset	the investment cost of new energy projects		
Т	the exercise period of the option	the term of investment for new energy projects		
r _f	the risk-free rate of return	the risk-free rate of return for new energy projects		
σ	the market volatility of project value	the volatility of the value of new energy projects		

Table 1: Variable definitions of model

Source: Author preparation

4. Empirical analysis

Next, we collect related data from wind power and solar power for empirical analysis.

4.1 Model parameter setting

(1) S: The investment income of new energy projects is mainly

sales income and state subsidies. The calculation of present value of investment income's expression is as follows:

$$R_t = Q \times H \times (1 - \alpha) \times F \tag{4}$$

In the expression, R is the investment income, Q is new energy generation installed capacity, H is the average utilization hour of new energy power generation equipment, α is the loss coefficient of new energy power station, and F is the electricity price of new energy generation.

(2) K: The investment cost of new energy projects is mainly the cost of power station construction. The calculation of investment cost's expression is as follows:

$$TI_t = Q \times I \tag{5}$$

In the expression, TI is the total cost of investment, Q is new energy generation installed capacity, and I is the unit cost level.

(3) T: The validity period of the new energy project is usually 2 years, and the qualification of the state funds is lost over the approved deadline. Therefore, the investment period of the new energy project is set for 2 years.

(4) $r_{f:}$ The calculation of risk-free interest rate is the two year time deposit rate of banks.

(5) σ : The calculation of the volatility is the annual average electricity price fluctuation rate. It is calculated that the value is 28.42%. If interest rates are adjusted several times a year, the average value will be adjusted.

By sorting out the data, the values of each parameter are shown by table 2. The data come from the National Energy Agency, NDRC and SERC.

Timo	S(billion RMB)		K(billion RMB)		r _f	σ
mie	Wind	Solar	Wind	Solar	(%)	(%)
2007	295	45	270	60	3.92	28.42
2008	482	65	543	73	3.82	28.42
2009	1117	48	1277	75	2.79	28.42
2010	1532	114	1684	156	3.20	28.42
2011	1427	323	1454	429	4.00	28.42
2012	1049	680	1031	610	4.08	28.42
2013	1302	985	1201	837	3.75	28.42
2014	1878	1355	1731	1024	3.55	28.42
2015	2422	1758	2311	1245	2.73	28.42
2016	1782	3388	1753	2487	2.10	28.42
2017	1499	4435	1455	3714	2.10	28.42

 Table 2: Parameter value of model

Source: Author preparation

4.2 Analysis of calculation results

Replacing the above parameter data into the B-S option pricing formula and NPV formula. The calculation results are shown by table 3.

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Table 3: Calculation Results								
C (billion RMB)	2007	2008	2009	2010				
Wind	70.12	68.51	143.31	224.93				
Solar	5.15	12.41	1.16	7.53				
C (billion RMB)	2011	2012	2013	2014				
Wind	265.51	213.19	300.75	429.96				
solar	39.25	212.60	334.41	548.30				
C (billion RMB)	2015	2016	2017					
Wind	495.69	329.24	286.11					
solar	758.98	1370.19	1460.69					

Source: Author preparation

The comparison results between real option method and net present value method of wind power projects are shown in Figure 1, and the results of solar power projects are shown in Figure 2.



Figure 1: Wind Power Projects



Figure 2: Solar Power Projects

It can be seen that the investment value calculated by the real option method are both positive and higher than the results of the NPV method. It shows that the decision value based on the real option method can reflect the investment value of the new energy project more.

This is mainly because the net present value method cannot reflect the uncertainty of the investment value of new energy projects. But, the real option method comprehensively considers the uncertainty factors in the investment of new energy projects, and confirms the feasibility of the investment.

5. Conclusion and Recommendations

In conclusion, this paper constructs the real option pricing model, and quantitatively analyzes the option value of new energy project investment, including wind power projects and solar power projects. It can be concluded that the real option method fully considers the uncertainty of the investment in new energy projects and is more suitable for the study of the investment pricing of new energy projects.

Therefore, we put forward the following suggestions:

- 1) The investors can use the real option pricing model to estimate the investment in new energy projects and implement the flexible and adjustable new energy project investment strategy, so that the investment scheme is more in line with the market needs, thus gaining more benefits.
- 2) According to the scale of new energy development, the new energy tariff policy should be adjusted accordingly. And, according to the technological progress and cost reduction of new energy industry, the price of new energy should be reduced appropriately, so as to achieve the goal of wind power and solar power's electrovalence parity.

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