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Research on the investment timing of commercial green property

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ABSTRACT

Green building is inevitable tendency in development. However, most of the developers in China are still waiting for the best timing. Compared with the ordinary ones, green buildings have features of more investment, higher risks, and more repayments. It is suitable for commercial property with consideration of life-cycle cost. How to choose the best timing of investment for commercial green buildings is important and urgent. This paper establishes a decision-making model with the real option theory for green buildings investment opportunity in commercial property and provides some advices to developers creatively, and tests the model by using a numerical simulation with an actual development project's data. It gives method for developer decision-making and advices to government for green building promotion.

KEYWORDS

Green building; Commercial property development; Investment timing.

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INTRODUCTION

Chinais in the accelerated process of urbanization and industrialization. There are tremendous opportunities for the real estate developmentin urban expansion. However, the building energy consumption accounts for almost 32% of the whole social energy consumption[1]. In December 2009, the United Nations Climate Change Conference (COP15) was held in Copenhagen, Denmark. The general assembly agreed thatenergy-saving and emission-reduction requiredthe concerted effort of the whole world. It wasdeclared that by 2020, the CO^2 emissionof GDPwould drop 40%~45% of 2005 in China. In the same year,a report by United Nations Environment Programme (UNEP)announced that 1/3 of the global energy use and the related greenhouse gas emission wereassociated withthe construction energy consumption. Therefore, green house and energysaving building will be the tendency in property development. It is helpful for the changeover ofcity construction modes, decrease ofenergy consumption and the sustainable development of building industry.

There areperfect practice and evaluation systems, such as BREEEAM and LEED etc,for green building. And there are a lot of outstanding green buildings in the world,but it is still in the preliminary stage in China. Approximately 99% of the existing building area (almost 40billion square meters) and 97% of new-building areais high energy consumption. The heating energy consumption are more than three times of those in developed countries[2].

The "Evaluation Standard for Green Building" and the financial support policy have been issued for the promotion of green building in China.Commercialpropertyhas becomehotspots of investment because of the macro-control in real estaterecently. The commecial real estate developers pay more attention to the operation costfor the energy consumption,such as servicedapartment, shopping mall and office building. That’s why it is more significant for green building in commercial real estate development.

Some foreign developers, such as Shui On Land Limited,havebegan to research energy saving in commercial property. Because of some factors such as the great uncertainty andheavy cost in early stage of development etc., developers are very cautious in green building investment in spite of its great commercial and social value. So we study the best investment timing of commercial green propertyby the real option method in order to provide a decision-making model for developers.

Dixit.et alfirstlyframed the analysis of corporate investment issues by the real option method[3]. It is very appropriate to study corporate investment issues by using the real option method for the huge randomnessof real estate market. The application research of this theoryin real estate investment by using the real option methodwas initiated by Titman[4]. He regarded option to defer as a non-dividendAmerican call options. Then, the real option method become more achivementsinresearch and is applied widely to the related-problems in real estate[5].(Yavas, et al.) Sing and K.Patel found that the investors had better wait for clearer message at the appearanceof high market uncertainty bythe empirical study on England real estate market[6]. The similar research in China includes: Cai et al. studied the decision-making of real estate investmenton the condition of randomness of price[7]. Ke et al. structured the multi-stage decision-making model according to the policies and features of real estate market[8]. Giving the uncertainty of demands and costs,Luo etc. studied the optimaltiming and the best development intensity for developers[9].

Based on the above studies, wediscuss the best opportunity for green buildings development compared the costs and returns between the normal buildings and green buildings forcommercial property. The innovation of this paper is providing reference to developers by the research in the circumstance of energy saving, and structuring the model with consideration of the accidents on random points based on the uncertainty of energy prices represented by Brownian motion in commercial property development.

MODEL DESCRIPTION

The construction cost of green buildings includesbuilding cost and operation cost (green buildings in this paper are all refers tocommercial green buildings without specification for convenience). Extra costs are needed during construction forGreen Building Standards, such as purchase of water-conservation equipments and air quality testing facilities. But theoperation cost, especially theenergy consumption, islower. Otherwise, the green building developers gain first-mover advantages in public praise, corporate image,leading technology, and raise comprehensive benefits. Green buildings have the commcial value such as cost reduction, building valueimprovement, fiancial subsidies and corporate image with quality.

The assumption is the developer prepare to develop a commercial propertyfor rent in this paper. It could be a normal building or a green building. So when is the best timing for green building is the most important decising-makingproblemfor developer. In the model, green building project is an investmentwith initial incremental costand subsequent continuous profit flow in abstract. The profit flow istheoperatingcost savings. The decision is developerneedsinput incremental sunk costfor financial subsidies and corporate image improvement.

There are some basic simplifying assumptionsto make the decision model feasible.

1. Risk-neutral Hypothesis. We assume the investor is risk-neutral in real option analysis because of the distorted option value by risk preference in decision-making process.

2. Development intensity is established. We studies whether developers choose green buildingwithout involvement ofdevelopment intensity in the paper.

3. Random process hypothesis. The real estate is supposed to display geometric Brownian motion and Poisson jump processin order to discribe its uncertainty.

4. Construction cost hypothesis. Compared with the normal building,theincremental costof per unit building area is$I$,and I is not the whole costs of development.

5. Risk-free interest rate hypothesis. The risk-free rate is assumed to be$r$.

6. Green building commercial value hypothesis. The commercial valueof green buildingincludestheoperation costsreduction,building valueand corporate image improvements,and subsidies,etc. θrepresents the operation cost reduction of green building,namely the profit flow. The invisible corporate valueimproved forunit areavalue is monetized by A, and B represents the government fiscal subsidies. Firsly, we assume thatθfollows a geometric brownian motion for it can characterize the uncertainties in energy price increase. Moreover,θ also has upward Poisson jumpson some random points,such as the fluctuation of energy price by war or emergency,some encouragement or punishment policies. Based on the two uncertainties above, we assume that θ obeys Brownian motion / jump process.

$$d\theta(t) = \alpha\theta dt + \sigma\theta dz + \theta dq \tag{1}$$

In formula1, α>0 and σ≥0. αrepresents the expected drift rate,andσrepresentsthe volatility. Formula1 shows thatθfluctuates as geometric Brownian motion,it rises in a small probabilityλdtat intervals of dtand continue fluctuating until another event. dq represents the increment of Poisson process with an average arrival rate ofλ. When the random increment occurs,q will risethefixed percentage φin the probability of 1,dq obeys formula2:

$$dq(t) = \begin{cases} \phi\theta(t) > 0\text{, Probabilit y } \lambda dt \\ 0 \quad\text{, Probabilit y } 1 - \lambda dt \end{cases} \tag{2}$$

In formula2,λ and φrepresent the intensity parameters of Poisson process. $\phi \ge 0, \lambda \ge 0$.

We choose the optimal investment strategybydynamic programming. Neutral-risk is assumed for the corporation so that the discount rate is risk-free. The Bellman equation of investment opportunity values

$F(\theta)$ is $rFdt = E(dF)$ **(3)**

Expanding formula3 by using the ItoLemma mixed the Brownian Motion and Poisson process,we will get :

$$\frac{1}{2}\sigma^2\theta^2 F_{\theta\theta} + \alpha\theta F_{\theta}(\theta) - rF(\theta) + \lambda F(\theta) - \lambda F[(1+\phi)\theta] = 0 \tag{4}$$

Assuming the solution of formula4 is $F(\theta) = L\theta^{\beta_1}$,and it is substitutedto formula4. β_1 is the normal solution for the nonlinear equation.

$$\frac{1}{2}\sigma^2\beta(\beta-1) + \alpha\beta - (r+\lambda) + \lambda(1+\phi)^\beta = 0 \tag{5}$$

Simultaneously, F (θ) obeys three boundary conditions:

$$F(0,t) = 0 \tag{6}$$

$$F(\theta^*,t) = \theta^* - (I - A - B) \tag{7}$$

$$F_\theta(\theta^*,t) = 1 \tag{8}$$

β_1 in formula5 hasno analytical solution,but we can find a β_1 in the number which can satisfy formula 5 and formula 6. Whenβ_1 is given,we can find the investment threshold θ * and L according to the boundary conditions 8 and 9.

From $L\theta^\beta = \theta - (I - A - B)$ and $L\beta\theta^{(\beta-1)} = 1$, the solution is:

$$\theta^* = \frac{\beta_1}{(\beta_1 - 1)}(I - A - B) \tag{9}$$

$$L = \left(\frac{\beta_1 - 1}{I - A - B}\right)^{\beta_1 - 1} \cdot \left(\frac{1}{\beta_1}\right)^{\beta_1} \tag{10}$$

θ^* represents thebusiness investment threshold. When$\theta(t) \ge \theta^*$, developer can choose green building. When$\theta(t) < \theta^*$, it should to wait.

NUMERICAL SIMULATION

The data involve in the model can be measured,so the model is strongly practicable.

TABLE 1 : The main parameters in the model

The input parameters	Values
the drift rate(%)	4
The incremental costs(yuan/m^2)	367
Risk-free interest rate(%)	7.05
Poisson jump intensity	0.05
Government subsidies	80
Corporate image value	50

For simplicity, the actual incremental profit flow of project is replaced by the power fare saving in this paper, and it doesn't affect the calculation. According to the incremental cost statistics of 77typical green building projects issued by the Ministry of Housing in November 2010, we find that the incremental cost of the three-star green buildingis 367 yuan per square meter. The risk-free rate is 7.05% according to the five-year lending rate issued by People's Bank of China in 2012. The green buildings abovetwo-star can be rewarded. The award criteria in 2012 is:45yuan/m^{2}for two-star green buildings and 80yuan/m^2 for three-star. The criteria will be adjusted along with thetechnical progress and cost variation. The parameters of the exampleis shown in TABLE 1. When σ＝0.05, φ＝0.05,we can get the results:

$$\beta_1 = 1.6273 \ ,\theta = \frac{\beta_1}{(\beta_1 - 1)} I = 614.8256$$

The profit flow of this investmentincludes the operating cost reduction and the rent increasement compared with normal buildings. θ indicates the total operating cost savings perunit building area of the green building. It is much more than the initialincremental cost of 367 yuan. σrefers to the volatility of the operating cost savings. φrefers to the intensity of the jumping. These two represent the relationship between the uncertainty parameter and thecoefficient of investmentthresholds.

Figure 1 shows the value of the investment thresholdθ* when φ = 0,0.05 and 0.1. We find the greater the volatilityσ and θ*, the greater the uncertainty, risks and profits. So the devleoper would wait for more profit. The larger the φ, the higher the investment threshold.

The three curves in Figure 1 are the graph of σ whenφ＝0.1, φ＝0.05 and φ＝0. When the othercoefficients are equal, the bigger θ and θ*, the higher the option value of investment opportunities. Meanwhile, the lower the waitingcost. So we can draw the conclusion 1.

Conclusion 1:From the critical value of investment, both the uncertainty of Brownian motion and the intensityof Poisson jumpcan strengthen the willingness to wait. In other words, developer had better postpone the investment decision when uncertainty.

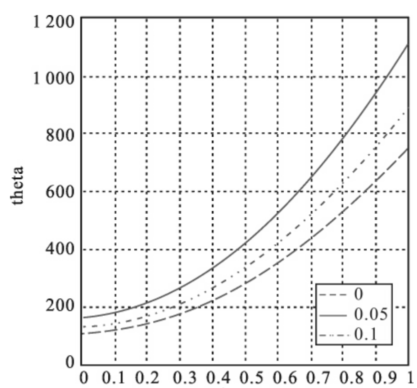

Figure 1 : Critical value of investment is function of uncertaity σ

EMPIRICAL TEST

Due to the simple structure and use rationality of the LEED system, the green building energy-efficient standards refer to itin this paper. The green buildings save 10% in energycompared with thenormal buildings in LEED, whichis used as the data basis.

In this paper, we take the commercial development project 'QYTD' in Chongqing as example. Assuming the service life of thecommercial building is 40 years, and it isusedfor 360 days per year. TheT1 building is a 31-storey office building of 41554m^2. Through the simulation,we finditsannual electricity consumptionis 7743900 kwh, andthe average annual power consumption is 186.3575 kwh/m^2. For LEED standards, the electricity savings of the green building is 26.09005 kwh/m^2, and the overall saving is 1084145.9377 kwh per year for 41554m^2. It cann't be ignored for the rising energy price.

Caculating by the optimal investment threshold θ*=952.0717,40 years of service life,7.05% of discount rate,26.090 kwh/$m^2$of electricity savings, the investment threshold is 1.778 yuan/kwh. The conditions for choosing green building is the electricity price raised to 1.778 yuan/kwh without consideration on the intangible values, such as corporation image, the first mover advantage and the environmental values, etc.

T1 uses the power distribution system of10kv/0.4kv with price of 0.828 yuan (data sources:the power company official website). The current electricity price doesn't reach the threshold, but thedeveloper still design and constructgreen building. This contradictoryresult is inherently rational for strong environmentalawareness and investment prospective for foreign developer, who pays more attention to the comprehensive effect and the corporate image. That is improving the figure of the corporation image value Ain the model. Changing the value of corporation image A and the subsidiesB, we can get the investment critical electricity price in TABLE 2 and drawthe conclusion 2.

Conclusion 2:whenthe values of subsidiesB and corporation image A are increasedwithotherconstant parameters,the willingness of green building development will be strengthened,the investment threshold and the waiting timewill be significantly lowered. That is, when the government subsidiesor image valueof green building is higher,partial incremental costs can be offset. It is easier for developer to make decision.

TABLE 2 : Investmentthreshold price on A, B

Corporate image value A (yuan/m^2)	Government subsidies B (yuan/m^2)	Critical price (yuan/kwh)
50	80	1.778
100	80	1.403
50	100	1.628
160	100	0.803

CONCLUSION

This paper usesthe real options method tostudy on theoptimaltimingof commercial green building development, by numerical analysis models. The result indicates that the higher the volatility of the uncertainties, the higher the option value and the trigger. Itis helpful for developer to choose the optimal timing and flexible decision-making method by quantifyingthe complex uncertainties in the economic environment.

Meanwhile, it can advise the government to promote the green buildingsdevelopment effectively in policy-makingby analyzinginvestment behavior. The policy suggestions are: The government should keep the stability of energy prices for green buildingspromotion,increase public awareness on green buildingby publicity of energy-savingand low-carbon lifestyle, andencouragegreen buildings by subsidies as well ascompulsory measures.

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