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Valuing a Real Estate Project using Real Options Approach: Is It Worth It?

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Real options valuation (ROV) has been a very useful tool for valuing risky asset under uncertainty. Unlike the discounted cash flow (DCF), ROV incorporates the uncertainty of project cash flow and investor's flexibility in dealing with such uncertainty. The uncertain asset value is usually represented as a continuous-time stochastic process, while the investor's flexibility is accommodated using embedded real options. In this research we investigated the application of ROV in a medium-scale real estate project in Indonesia. We found that the investor did not have much flexibility due to government regulations and the industry's business model. We assume that the asset's value follows a geometric Brownian motion with constant volatility. The risk-free interest rates are represented using Nelson-Siegel model. Using Cox Ross & Rubinstein (CRR) binomial lattice, we found that the project's value using ROV is slightly greater than that of using DCF. We also conducted sensitivity analysis against changes in the volatility value.

Keywords: *Real estate, real options valuation, geometric Brownian motion, Nelson-Siegel.*

1. Introduction

In Indonesia, landed house is considered a lucrative investment and believed to be of small risk. Decision to invest in landed houses is—most of the time—easy to make. Is it also true for the other side of the market? We are interested to investigate the riskiness of developing a real estate project on an already-acquired land using real options valuation (ROV). ROV is superior to conventional discounted cash flow (DCF) in analyzing investment under uncertainty since it (1) incorporates the uncertainty of cash flows, (2) accommodates investor flexibility in dealing with such uncertainty in terms of embedded real options, and (3) uses risk-free rate[1]. The use of risk-free rate eliminates the most difficult problem in implementing DCF, which is calculating the risk-adjusted rate[2,3].

Theory on real options comes from that of financial options. An option is the right to do something. Financial options are those whose underlying asset are financial (e.g. stock). There are two types of options, call and put. A call option is the right to buy an asset for a pre-specified price (strike price) by a certain date (expiration date), while a put option is the right to sell, under the same condition. Option can be of American (exercisable up to expiration date) or European (exercisable only on expiration date) type.[4]

Initially, we consider three types of real options for this investment problem, i.e. option to defer, switch, and abandon. Under real options, a single irreversible investment alternative competes with deferring itself. This is not only due to the stochastic nature of the project value[5], but also in the case where the project value is deterministic but the interest rates are stochastic[6]. The relevant option to switch in our problem is option to switch output, i.e. from landed residential houses to a mix of residential houses and commercial buildings. Regarding the option to abandon, it is equivalent to an American put option on the value of the project with the selling price as the strike price and project's end date as the expiration date[5].

The value of an asset is the expected NPV of all cash flows generated by the asset during its life. An important notion in option pricing is risk-neutral valuation, which states that risk preference becomes unimportant when we are pricing an option based on the price of the underlying asset[1]. A change in the investor's risk preference will affect the price of the asset, but the relationship between asset price and option price remains the same. Valuing an asset in a risk-neutral world is much simpler because we can use risk-free rates as the discount rate. All embedded real options that we considered in this investment problem are of American type in which analytical solution as the Black-Scholes-Merton (BSM)[8,9] model is not possible. Alternative methods are binomial lattice, finite-difference, Monte Carlo[1], and mathematical programming[10,11,12,13]. The last method comes from the fact that this problem is a typical dynamic programming problem[14]. We use binomial lattice as it is more intuitive. Specifically, we use one suggested by Cox, Ross & Rubinstein (CRR)[15].

2. The Model

We assume that the value of the underlying asset—the project value, S—follows a class of continuous-time stochastic processes, i.e. geometric Brownian motion with drift of μ and constant volatility of σ under the following diffusion process: $dS = \mu S\, dt + \sigma S\, dz$, where dz is a basic Wiener process with zero drift rate and variance rate of 1. According to CRR, this process can be discretized using a binomial lattice, which—under proper parameters selection—converges to the corresponding continuous-time process when Δt is small[15]. The corresponding lattice represents possible paths that might be followed by the project value over its life. For the lattice in our problem, we labeled the n^{th} node from the top of period t as node $[t, n - 1]$.

The underlying assumption of binomial lattice is that the project value follows a random walk. Suppose S is the project value at $t = 0$. At $t = 1$ the project value is either in one of two possible states, i.e. increased to uS with probability p, or decreased to dS with probability $1 - p$. But, this is only true for a project with relatively steady annual cash flows. The cash flow pattern of a real estate project is not steady. The first 1-2 years usually have negative or small positive net cash flow, while the remaining years are the years of selling with significantly greater positive cash flow.

For a certain period t, we assume that the cash earned up to time t is invested at a risk-free rate. The value of the project without real options at node $[t, n - 1]$ equals the value of the cash earned up to time t plus the remaining value of the project at time t, multiplied by a compounding binomial factor of $u^{t-n-1}d^{n-1}$. CRR argue that in order to converge to the corresponding continuous-time process, the parameters of the lattice should be as follows: $p = \frac{e^{r\Delta t} - d}{u - d}$, $u = e^{\sigma\sqrt{\Delta t}}$, and $d = e^{-\sigma\sqrt{\Delta t}}$, where r is the risk-free rate[15]. Since $d = 1/u$, this is a recombining lattice.

The project values at different periods were estimated based on the cash flow schedule from the developer. There were two scenarios of cash flow called scenario minimum and scenario maximum. Scenario minimum assumes a worse condition in which they need seven years to sell all houses, while scenario maximum assumes a better condition in which they can sell all houses in five years. Further discussions with the developer revealed that the NPV from scenario minimum would be the minimum value and the NPV from scenario maximum would be the maximum as well as the most likely value. Assuming a triangular distribution, we estimated the expected value of the project as $S_0 = \int_a^b x\, f(x)\, dx$, where a is the NPV from scenario minimum, b is the NPV from scenario maximum, and $f(x)$ is the probability density function of a triangular distribution with minimum value of a, maximum value of b, and most likely value of b.

From three types of real options that we initially considered, further discussions with the management suggested that only abandon option was feasible. Although government regulation allows developers to defer the development project up to two years following land acquisition, the management deemed this option infeasible. This developer is not a big company, hence it is always more desirable to have high turnovers, i.e. finish the project as soon as possible and invest the money in a new project. There is no strategic value of waiting for this company. Option to switch turned out to be infeasible due to government regulation. Once the company is granted a permit to build a project of landed houses and the development starts, it is unlikely that the permit changes to mix of residential and commercial buildings. Option to abandon gives a significant payoff when it is exercised during the first two year of the project's life. However, it is unlikely that a developer would take over the project during that period. In Indonesia, real estate developers earn most of their profit from the increase in land's value. This suggests that it is always more profitable to abandon the project before the development begins, assuming that someone would buy it. But, since all developers have the same business model, it is unlikely that any of them would buy. Therefore, we only consider the option to abandon starting in the third year when the development has started and some of the houses have been sold.

Since there is no historical data about return or cash flow from similar projects, we adopt the volatility value from Ciochetti et al. which studied 4,093 properties in the United States in the period of 1978-2002[16]. The risk-free interest rates are estimated using Nelson-Siegel model[17] calibrated using data from the Indonesia Government Bond yield curve rates. In the Nelson-Siegel model, yield to maturity at expiry date m, $R(m)$, follows $R(m) = \beta_0 + (\beta_1 + \beta_2)\frac{\left(1-e^{-\frac{m}{\tau}}\right)}{\frac{m}{\tau}} - \beta_2 e^{-\frac{m}{\tau}}$, where β_0, β_1, β_2, and τ are model parameters. We used least squares method to determine the model's parameters, based on which we can determine the zero rates and forward rates[4]. The binomial lattice is then solved by backward recursion from terminal branches at time T (expiration date), and moving forward to evaluate the value at each node as the expected value of all branches emanating from that node continuously-discounted at risk-free rate, r. At each node, we compare the expected value of do-nothing with those of independent execution of embedded real options.

3. Results and Discussion

We divided the time horizon of seven years into three-month intervals. Adopting the constant volatility of 0.0805 per year from Ciochetti et al.[6], we developed a binomial lattice for the project value accordingly, with $u = 1.020$ and $d = 0.980$. At each period, the project values were estimated using expected value of project's NPV discounted at $WACC = 12\%$. At $t = 0$, we obtained $S_0 = 17{,}313{,}871{,}505$. We use S_0^D as the notation for the project value under DCF approach, which is equivalent in value to S_0. Using least squares method, we obtained the Nelson-Siegel model for the zero rates, $R(m) = 0.0758 - \frac{0.0229}{m}\left(1 - e^{-\frac{m}{0.4421}}\right)$. Subsequently, we computed the forward rates and the probability of up movement, p, and the probability of down movement, $(1 - p)$ at each period. Using these information we conducted the backward recursion from $t = 28$ down to $t = 0$, where at each node we compared the payoff of do-nothing with that of exercising the abandon option. The abandonment values were calculated by considering a moderate increase in the land's value and assuming certain proportion of the houses that have been sold. We came up with the value of the real-options-embedded lattice at $t = 0$, $S_0^R = 18{,}751{,}778{,}365$, an 8.3% increase from that of DCF, $S_0^D = 17{,}313{,}871{,}505$. The option to abandon is exercised at nodes [19,17] – [19,19] and nodes [20,8] – [20,20].

We conducted sensitivity analysis to investigate the effect of volatility changes to the project value. We varied the volatility value by a factor, k, ranging from 0.25 to 3.0, and observed 6.87% to 12.33% increase in the project value. This relatively small increase raised the question whether the use of ROV in valuing real estate project is justified. A number of factors were attributable to this relatively low real options value. The main factor could be the fact that the developer has a very limited strategic options regarding the project. To some extent, this is due to the nature of the company which is of medium size with limited cash flow. In the same situation, a bigger company may have more options, e.g. option to defer, option to expand, and time-to-build option. The result from sensitivity analysis suggests that volatility does not have much impact on the real options value. This is in part due to the limited real options that the company has.

We adopt the volatility value from an extensive study in the United States, which may not suit the condition in Indonesia. That is why we conducted sensitivity analysis. For the risk-free rate we have considered the impact of time by using Nelson-Siegel model. The interest-rate model could be enhanced by using stochastic ones[18,19,20].

4. Conclusion

The application of ROV to a medium-scale real estate project resulted in a small increase in NPV. One factor may significantly contribute to this result, i.e. the nature of the company which limits the available real options. Despite the relatively low value of real options, ROV is still a useful tool for optimizing real estate investment plans. It may not be as useful in the stage where the developer needs to conduct the feasibility study, but it would be of great benefit when the project starts to roll on. As we would not be able to completely predict the future, having a framework that would help us make optimal decisions regarding the uncertain future is always favorable.

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