A REAL OPTION APPROACH TO VALUING THE OPTION TO DEFER IN A RESIDENTIAL PROJECT IN MELBOURNE, AUSTRALIA

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ABSTRACT

Property development feasibility evaluation is a precursor to any real estate development activity. The evaluation is predominantly calculated via the use of discounted cash flow (DCF) technique to quantify the future benefits to determine viability of the development. The DCF has been criticised on grounds of inflexibility and that it fails to evaluate real estate projects properly, leading to bias in the results.

Real options theory has been proposed as a solution to the deficiencies in the DCF and to complement it. However, the real options theory has lacked practical adoption by industry due to the unavailability of comprehensive evidence to support its application in practice. The purpose of this paper is to examine a practical application of real option to a residential real estate project and compare the results with DCF to determine which of the methods deliver superior results.

Dynamic programming, specifically the certainty equivalence approach of the binomial real options pricing model is applied to an actual Australian residential development project. The binomial option pricing method is a discrete time model and uses the multiplicative stochastic process to project the price evolution of the underlying real estate development value and complements the existing valuation methods to deliver better results.

The real options valuation gives the developer a reason to hold uncertain projects over a period of time before commencing development. This mitigates the risks associated with projects and leads to the retention of projects that would have otherwise been abandoned by the DCF technique of evaluation. It was found out that should the developer wait until it is optimal to start development, the flexibility would add $2.58 million to the value of the development which would account for about 3.3%.

This is the initial application of the certainty equivalence approach of the binomial option pricing method to evaluate an Australian residential case study project. The method risk neutrally calculates the potential range of the value of the real estate asset over a period of time, determines the optimal timing for commencing development and provides an intuitive way for developers to make decisions regarding immediate development or delaying the timing of developments over a period of time to mitigate risks.

Keywords: discounted cash flow, uncertainties, valuation, real estate development, binomial option pricing method

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1.0 INTRODUCTION

Property development is complex and requires a considerable period of time to materialise. It is fraught with risks that emanate from uncertainties with future cash flows, costs, interest rates, demand, sale prices, regulatory changes, unsold completed units and apartments as well as cost of land from the local government. The impact of uncertainty have been studied by several leading authors including (French & Gabrielli 2004; French & Gabrielli 2005; French & Gabrielli 2006; Loizou & French 2012). Such uncertainties have profound effects on the financial outcome of property developments, especially when the static discounted cash flow (DCF) technique is the most widely used in modelling real estate investment decisions.

The static DCF's inability to evaluate uncertain future payoffs from investments have been explored by several authors. For example Sirmans (1997) opposed the traditional DCF model and suggested that, it is insufficient for evaluating real estate projects because it fails to capture potential future changes in the property market to capitalise on emerging opportunities while limiting downside losses. The procedure for selecting discount rates is also quite subjective and lacks transparency (Hayes & Abernathy 1980; Hodder & Riggs 1985). A further limitation is that capital budgeting theory in textbooks on the subject, concentrates almost exclusively on the financial criteria for selecting projects with future uncertainties (Brealey & Myers 1988; Brigham & Gapenski 1991). Even though the numbers are relevant to analysing development projects feasibility, there are other managerial decisions that affect the outcome of the analysis.

Trigeorgis (1996) developed a taxonomy of real options and categorised them as option to defer, time-to-build, option to alter operating scale, option to abandon, option to switch, growth options and multiple interacting options. Based on this taxonomy, Lucius (2001) identified these managerial decisions in real estate and categorised them also into defer (an option to postpone a project which is presently not viable until a future date), abandon (discard a project entirely), alter scale (expansion of contraction), and stage development (sequential approach to construction). In real estate development, the dynamics of the market combined with the complex duration of development makes projections very difficult. In view of this, relying on subjective estimates based on market expectations using the DCF model only results in myopic decisions. These managerial flexibilities in real estate development offer developers the chance to alter future decisions based on new information as uncertainty resolves. In view of these flexible managerial decisions embedded in real estate projects, uncertainties can be better managed rather than using risk adjusted discount rates to manage uncertainties. Luehrman (1998) argued that a superior evaluation approach must capture both the uncertainties and the dynamic management essential for a development project to succeed.

Guthrie (2013) suggested that in a world of volatile market conditions, the ability to change course due to the arrival of new information including slowing down or discarding construction, and resuming it at a later date, can be extremely valuable. Atherton et al. (2008) suggested that, the consideration of uncertainty through the use of a range of figures can have meaningful impact on normative models in the feasibility analysis of real estate development projects. Through the real options framework, such flexible managerial decisions can be evaluated to determine whether the embedded option has value or otherwise. However, the adoption of the real options method in practice has been very slow (Bennouna et al. 2010). In view of this, more cases in real life setting are needed to prove the applicability of the theory and its benefits in practice which is supported by (Geltner & de Neufville 2012). Therefore, in this study, a real life case is adopted to evaluate the option to defer in a brownfield real estate project that was discarded using the NPV derived through the DCF method.

2.0 LITERATURE

Real options method has been applied in different areas of real estate decision making. All these applications are part of attempts by leading authors to demonstrate the potential of real options in real estate decision making. For example in the pricing of leases, Grenadier (1995) developed a real option model for valuing lease contracts, Sing and Tang (2004) evaluated leasing risks in commercial property and Sing (2012) used a multi period binomial options pricing to value default options embedded in percentage lease agreements in retail leases. In addition, both Ward et al. (1998) and Ward and French (1997) applied real options to the valuation of upward only rent review clauses in leases and Hendershott and Ward (2000) model the overage rents as a call option depending on the sale turnover of the tenants. Another areas of real options application in real estate decision making that has been studied by leading authors is the flexibility that can be embedded in real estate projects to enhance risk assessment and create future opportunities for property investors and developers. de Neufville et al. (2006) studied the application of real options to a parking garage development, Guma et al. (2009) examined the vertical phasing of a corporate real estate office in the US,

Geltner and de Neufville (2012) evaluated the phasing of a large urban development and Vimpari et al. (2014) valued the flexibility in the retrofitting of a corporate real estate office using real options. Vimpari and Junnila (2014) also evaluated option to wait embedded in the active management of a residential real estate fund divestment. The option value derived was 6.6 per cent which represented the value appreciation that would be achieved, should the multiple transaction strategy be adopted. Vimpari and Junnila (2014) further argued that standard industry valuation approaches including DCF misses out on the value of this flexible approach to divesting a portfolio of assets in a real estate fund.

The value of waiting to invest was examined by McDonald and Siegel (1986) and supported by Dixit and Pindyck (1994) who suggested that the value of an investment must be high enough to justify giving up the option and the option premium to invest. In other words, developers of land must consider developing only when the value of the development is high enough to compensate for the lost of future opportunity value embedded in the option. Other leading authors including Trigeorgis and Mason (1987) have suggested that, the option pricing techniques deliver results better than the static DCF approach in capital projects evaluation. In real estate applications, valuation of land development as an option was pioneered by Williams (1991) who concluded that, the presence of real option explains vacant undeveloped urban lands in Seattle. Quigg (1993) applied the options theory to land development and concluded that the value of development should include the option value if development is delayed in addition to the immediate use. Cunningham (2006) also studied house prices uncertainty and the timing of development of vacant lands. Generally, the option to develop a vacant land is examined as a timing option of waiting to invest dependent on the emergence of new information in the market. In a more recent study, Geltner et al. (2017) empirically estimated development asset value index (DAVI) for commercial property and compared it with a corresponding traditional transaction price based hedonic property asset price index (PAPI) which has been corrected for depreciation within the same geographical real estate market. It was argued by the authors that the difference between the DAVI and PAPI is a reflection of the realized value of timing flexibility embedded in land development from the options perspective.

The option to delay the start of a development project is connected to the irreversibility of land development decisions. Capozza and Li (1994) showed that intensity of development interacts with timing of development, taxes and project values. Based on a one factor contingent claim valuation model developed and tested by Sing and Patel (2001), it was found that embedded timing options in land development had an average premium of 28.75% for office sector, 25.75% for industrial sector and 16.06% for retail sector. Leung and Hui (2002) examined embedded options in real estate projects in Hong Kong Disneyland. Real option to defer embedded in the project was valued using a binomial option pricing method. Sing et al. (2002) developed a real options model and used it to empirically evaluate options premiums associated with five selected "white sites" in Singapore. Chiang et al. (2006) adopted the real options approach to identify and evaluate the options embedded in a vacant land and argued that real options including defer, expand, switch and contract that are embedded in real estate projects cannot be evaluated using the DCF approach. Later, a redevelopment option was also evaluated by Clapp et al. (2012) and identified the value of development potential existing in buildings under cyclical conditions. Guthrie (2013) also evaluated a real estate project using the binomial option pricing method. Guthrie claimed that the DCF model underestimates the true value of projects because the flexibility of delaying phases of projects can add value to real estate developments and lead to optimal timing for construction. Thus, there can be value maximisation in using real option models for evaluating real estate projects.

Similarly, Baldi (2013) used the binomial option pricing method to evaluate a green field real estate development project located in Italy. Results from the study indicated that, the real option model valuation derived higher values than the DCF model in two separate phases of construction where the option to delay was considered. Before construction, the deferral option accounted for 26% of total value and 13% after stage 2 when the delay option was evaluated. Baldi (2013) study did not consider the impact of construction period on the option to delay. Besides, the development was on a greenfield development which has no extra cost of cleaning the land and demolition before commencing development.

Quite recently, Shen and Pretorius (2013) constructed an option pricing model for real estate development by considering and incorporating institutional arrangements, direct interactions and financial constraints. Through application of the model, the authors found that contractual covenants, positive synergies between properties and financial status of a firm, which enhance or restrict real flexibility embedded in development land, influence project value and investment timing. Yao and Pretorius (2014) developed and tested a long dated American call option pricing model for valuing development land under leasehold. Using 10 case

studies involving purchase, holding, converting and developing land drawn from Honk Kong, the authors analysed and tested for optimal exercise of the long-dated American call option. The findings showed a positive mean option premium value of +5.27 per cent in the selected cases.

These studies on option to delay/wait discussed above have supported the application of option pricing techniques to the evaluation of property investments, especially for maximixing value of options due to uncertainties in the values of future real estate prices. The timimg of real estate investments are important because once the decision is made to commence development, the option to postpone is lost. Due to some characteristics of real estate developments such as the low liquidity of assets, size of developments, location and type, timing of commencing developments is important in the real estate sector. It is essential for developers to get the timing of property developments right in order to avoid potential losses. Land development is a recurrent situation in property development and the embedded option to delay can be valuable. In this paper, the purpose is to continue exploring the potential of option pricing techniques application to real estate projects with the aim of finding further evidence needed to support the adoption of the technique in practice. More importantly is the use of the technique to evaluate a development of a brown field site located in Melbourne which is an initial application of the technique. Development of Brownfield sites have the potential to escalate costs of development due to either paying off existing occupiers of the land, businesses operating on the land, demolition costs and cleaning of contamination. In the following sections, the paper describes the particular option pricing technique used for evaluating the case study project, description of case study, results and conclusions.

3.0 METHODOLOGY

The binomial option pricing method has been widely used by leading authors in the evaluation of real options embedded in real estate projects as developed by Cox et al. (1979). A variation of this model called the certainty equivalent approach of the binomial option pricing method has also been developed and explained in Geltner et al. (2007). In this paper, the certainty equivalence approach of the binomial option pricing method was used to evaluate the option to defer embedded in the real estate project. In modelling the evolution of both future value and costs of the project, it was assumed that construction costs had a stochastic process in Equation 1 of the form

Equation 1

$$C_{n+1} = C_n * (1 + CPI_{avg})$$

Where

Cn+1 = development cost of the next period,
Cn = development cost of the current period
CPIavg = Average of 20-year consumer price index
The property value tree evolution however is deemed dependent on the capital growth rate for properties in North Melbourne, the location of the case study as in equation 2 and of the form

Equation 2

$$gv = \frac{(1 + r_v)}{(1 + y_v)} - 1$$

Where

gv = the expected annual growth in the value of the residential building
rv = expected annual total return on residential property investments
yv = the net rental yield on residential property investments

In modelling the asset tree, at any point in time during the evolution of the residential project's value, it is assumed that there are only two possible state values of the project: either an upward (*u*) movement with probability *p* or a downward (*d*) movement, with probability *1-p (Cox et al. 1979),* where *p, u* and *d* are given by;

Equation 3

$$p = \frac{(1 + r_v) - d}{u - d}$$

Equation 4

$$u = 1 + \sigma\sqrt{T/n}$$

Equation 5

$$d = \frac{1}{u}$$

Where

σ_v = expected annual volatility of returns on residential property investments
T = the total time in the binomial tree (in years)
n = the total number of periods within the tree making T/n a fraction of a year within any single period in the binomial tree.

Defining the current value of the residential project as V_t, then the value of the project in the next period in an up movement (*u*) is defined in equation 6 as

Equation 6

$$V_{t+1}^{up} = \frac{uV_t}{1 + y_v}$$

Similarly, a down movement in the next period can also be defined in equation 7 as

Equation 7

$$V_{t+1}^{down} = \frac{dV_t}{1 + y_v}$$

Using equations 6 and 7, the potential values of up and down movement of the residential apartment project were derived and used for the computation of real option values. The extent of *up* and *down* movements are calibrated in such a way that, together with the volatility and time, it results in a normal distribution of a range of values as the estimated discrete time periods approaches the limit (∞) (Geltner et al. 2007). The annual volatility for the value evolution is given by the GARCH (1,1) model in equation 7of the form

Equation 8

$$\sigma_n^2 = \gamma V_L + \alpha\mu_{n-1}^2 + \beta\sigma_{n-1}^2$$

Where

σ_n^2 = estimated variance for time n
γ = the weight assigned to the long-run average variance rate
V_L = long run variance, α= weight assigned to long run average return
$\mu2n-1$= long run average return of residential property investments
β = weight assigned to variance of the previous period
σ_{n-1}^2 = variance of the previous period

The potential value of the residential project in a particular market situation $V_{i,j}$, can be derived in the form of a tree of asset values based on *u, d* and *p* as in Equations 4, 5, and 6 respectively. Afterwards, the certainty equivalence equation for evaluating the American call option to delay on the residential apartment project is given by Equation 9 of the form

Equation 9

$$C_{i,t} = MAX \left[V_{i,j} - K_j, \frac{(pC_{i,j+1} + (1-p)C_{i+1,j+1}) - (C_{i,j+1} - C_{i+1,j+1})\left[\frac{r_v - r_f}{(1+\sqrt{T/n}) - 1/(1+\sigma\sqrt{T/n})}\right]}{1+r_f} \right]$$

Where

$V_{i,j}$ = Value of the underlying asset at period j
i = the total number of down outcomes out of j periods
K_j= Construction cost at period j, corresponding to V at the same period
$C_{i,j}$= Value of the option (land price) at period j
p = the probability of an up movement and other variables such as r_v, σ_v, T, n and r_f are as already defined. These parameters were used in the certainty equivalence approach of the binomial option pricing method to derive the expected values and the American call option values to develop.

3.1 Data and Case Study Description

The residential project is located in North Melbourne along a major arterial road that links the Melbourne CBD and the Tullamarine international airport. In close proximity to the location is the CBD (9 kilometres), Carlton, North Melbourne and Royal Park, making it very accessible to all the major retail outlets in the city and other amenities that are important for city living. Figure 1 displays the area of location of the case study but for confidentiality purposes, the exact location is not shown in the Figure. The site is rectangular and supports the development of residential apartments without difficulties with an approximate size of 1,045m². It was brownfield site which was acquired by the developers for the project.

Figure 1 Location for the apartment development project in North Melbourne

Source: Developer, 2016 (address not shown to protect the confidentiality of the developer)

Two Tram and bus stops are just a block away from the site and serves as a major attraction to investors and owner occupiers of residential properties. The total number of apartments was 143 in a mix of 1 and 2 bedroom apartments that were targeted at the investor market and 2 bedroom plus study and 3 bedroom apartments targeting owner-occupiers. The design of the development also incorporated a basement car parking for most of the units. Figure 2 shows a similar completed apartment block (the author used a similar building to the case study in order to protect the confidentiality of the developers), levels and the size of the development.

Figure 2 Completed apartment building

Source: ABC (2016)(building is similar to case study, actual building not shown due to confidentiality)

3.2 Data on the North Melbourne Case Study Project

The data for the project was supplied by the developer (a leading public real estate company) and was relied upon as true information for the evaluation of the case study. The application of the option to delay the development was based on stepping back in time to the year 2012 when the project began and all figures are in Australian dollars. The estimated value (undiscounted) and cost (undiscounted) for the development were given to be around $83.79 million and $77.57 million respectively. The expected rate of return (WACC) was 8.9% and cost discount rate was estimated to be 5.5%. The information given above was used for the DCF evaluation of the project to determine its viability. Forward volatility of residential investments using the GARCH (1,1) model was calculated to be 6.79%. Risk free rate for the risk neutral valuation was also calculated as an average of a 10-year Australian government bond rate to be 2.34% using data from Reserve Bank of Australia. It was assumed that the period for deferral was 12-months because developers are normally constrained by time and planning permission. A 10-year average of consumer price index was calculated to be 2.38% based on data from Australian Bureau of Statistics and was used as a proxy for construction price increases per annum because of the deferral. In this paper, the average of annual total return and rental yield of residential real estate investments in Melbourne was calculated to be 10.2% and 5.53% respectively using a 10-year data from 2005-2015 sourced from RP Data, a global property data provider. These information were used in the modelling of the value tree and cost tree as well as computation of the real option values.

4.0 RESULTS AND DISCUSSION

As the market dynamics keep changing, cost of constructiion materials also vary. The result is that the development cost for the residential project during the deferral period would increase from the initial estimate of around $77,570,000 to about $79,430,000 as displayed in Figure 4. The cost figures are same in every state of the market because they are assumed to increase at same rate at every stage in the binomial tree. In practice, hardly do construction costs decrease, thereby supporting such an assumption. As the market keeps changing, prices of goods and services also keep changing and affects construction prices. The result is that, the development cost for the residential project during the deferral period would increase from the initial estimate of around $77.5 million dollars to about $79.43 million. The linearity of cost changes of the development can be seen in Figure 4 because the cost figures increase at the same rate at every step in the tree. The potential values of the apartment from the commencement of the deferral period to the end of the 12 months is displayed in Figure 5.

Figure 4 Binomial tree of costs for apartment project over a 12-month period during delay

periods (j)	0	1	2	3	4	5	6	7	8	9	10	11	12
down moves(i):													
0	77.57	77.72	77.87	78.03	78.18	78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
1		77.72	77.87	78.03	78.18	78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
2			77.87	78.03	78.18	78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
3				78.03	78.18	78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
4					78.18	78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
5						78.34	78.49	78.65	78.80	78.96	79.12	79.27	79.43
6							78.49	78.65	78.80	78.96	79.12	79.27	79.43
7								78.65	78.80	78.96	79.12	79.27	79.43
8									78.80	78.96	79.12	79.27	79.43
9										78.96	79.12	79.27	79.43
10											79.12	79.27	79.43
11												79.27	79.43
12													79.43

After 12 months of deferral/waiting, the potential value of the apartment development project increases from the initial value of $83,790,000 to a highest possible value of about $100,100,000 in case there is favourable market. However, in an unfavourable market, the potential value of the residential project decreases to a possible minimum of around $62, 810,000.

Figure 5 Binomial tree for value evolution of apartment project over 12-month period of delay

Between the maximum possible value and the minimum possible value are other potential values that can be realised from the development. This leads to the development of a range of values from which real option value can be calculated to represent the potential value of the asset in future (12-month period). The real option method considers a range of values rather than a single point estimate for evaluating viability of real estate projects thereby enhancing the financial viability assessments. Figure 5 displays the potential value changes during the period of deferral of the residential real estate project. The value tree shows the recombination of the lattices, thus an upward and downward movements converges to the same figure, as theorised by the binomial option pricing theory which requires the lattices to recombine after every *up* and *down* movement.

Figure 5 displays the potential cost chnages during the period of deferral of the residential real estate project. After a deferral period of 12 months, the residential project must be constructed before the developer can realise the value from the development. The data indicated that the construction period was 2 years. Using 2 years for the construction period for both costs and value, 10.23% discount rate for revenue and 2.45% for costs, the values of both costs and revenues were discounted to present values. After calculating the present values, the potential maximum value decreased by approximately 10.5%, the most likely was reduced by 10.44% while the minimum value decreased by 10.42%. The cost discounting resulted in a reduction of around 0.14% which was lower than decreases in the value component. Naturally, because the values and costs change with the discounting, it changes the real option value and consequentially the exact timing the option should be exercised or the project should be developed.

The real option value of the project are shown in Figure 6 as computed using the certainty equivalence approach of the binomial option pricing method. The American call option on the project was determined to be $0.29 million at present as circled in Figure 6. This real option value is relevant in the decision making of the property developer of this specific project because it is compared to the value of the project today to determine the optimal time to begin the counstruction of the development. Thus, the decision to start construction is based on the value of the real option at each node by comparing its continuous value of waiting and the current profit from developing the project. The development project is only executed when the current pay off is greater than the real option value of continues waiting because the timing is optimal at that point.

At present, the AUD$290,000 million payoff is less than the real option value of continuously holding, so the optimal decision is to hold onto the option to develop until the pay off is greater than the option value. The pay off value currently accounts for about 0.37% of profits on cost of the development which would have been an incentive for the developer to execute the project as compared to the DCF valuation results. However, it is not the optimal time for development to commence because the real option value is higher than the pay off from the the project, hence exercising the option is not financially prudent.

The optimal timing for the development project to commence is given by the ratio of current value and constrcution cost. This ratio must be high enough to trigger optimal time for the development of the project instantantly. At that point, the benefit cost ratio is higher than the value of giving up the option (value of waiting to invest). Therefore as shown in Figure 7, at periods where the pay off is higher than the option value and the premium, the corresponding optimal decision is to exercise (exer) the option to develop immediately. At specific periods where the benefit cost ratio is less than the option value and the option premium computed as shown in Figure 7, the corresponding optimal decision at that period is to hold on to the option embedded in the development until uncertainties are resolved. Figure 7 displays the different periods and the optimal decisions concerning the residential development project with a 'hold' sign meaning the developer should wait until uncertaities resolve and 'exer' suggesting the developer should immediately exercise the option to develop.

Period (0,1) which has an option value of $0.46 million has an optimal decision of holding onto the development. However, starting from month 5 until month 12, it is a blend of optimal decisions of exercising the option immediately to develop the land and holding onto the option to develop land. It can be observed that some periods including (0,5), (0,7), (0,12) are all indicating optimal times for exercising the option to develop immediately because the payoff is greater than the option. At these periods, the payoffs are high enough to justify giving up the option of holding. Holding onto such options at these periods is not optimal. For example in month 5, the optimal decision is to exercise the option because the payoff at that point will be

$2.58 million which would account for 3.3% profits on the undiscounted costs of the development, hence profitable to initiate development as shown in square in Figure 6.

Figure 6 Real option values for apartment project over 12-month delay and 2-year PV

j Period :	0	1	2	3	4	5	6	7	8	9	10	11	12
i down moves													
0	0.29	0.46	0.72	1.11	1.70	2.58	3.64	4.71	5.79	6.90	8.02	9.16	10.33
1		0.09	0.15	0.24	0.40	0.65	1.04	1.64	2.57	3.63	4.71	5.80	6.91
2			0.02	0.03	0.06	0.10	0.18	0.30	0.52	0.89	1.52	2.56	3.63
3				0.00	0.00	0.01	0.01	0.02	0.04	0.08	0.14	0.26	0.47
4					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6							0.00	0.00	0.00	0.00	0.00	0.00	0.00
7								0.00	0.00	0.00	0.00	0.00	0.00
8									0.00	0.00	0.00	0.00	0.00
9										0.00	0.00	0.00	0.00
10											0.00	0.00	0.00
11												0.00	0.00
12													0.00

Source: Author, 2016

Initial results from DCF application suggested that the development was financially not viable because the potential NPV was $-1,927,331 using a discount rate of 8.94% for revenues, 2.34% for costs and 5 years for the period of development. Comparatively, real option valuation gives positive outcome for this project, suggesting that the project has the potential to be financially feasible whereas DCF results suggests the project should be rejected. This demonstrates the potential of real option valuation models in the evaluation of capital projects and the value underestimation of DCF technique in real estate projects evaluation. Real options analysis suggest that the project should be held over a period of 12months because it has potential to become financially viable. Because it is an American call option on the residential project, the project could be commenced at any time within the 12 months of deferral when optimal. As a result, different decisions concerning exercising the option or holding it may be taken by the land owner/developer at specific times during the waiting period.

In addition, because developers can wait until a specific time when uncertainties are resolved before commencing construction, the risks associated with developments are mitigated as developers know the exact time to commence developments. In view of this, during downturn in property markets, the downside associated with developments are dealt with via a real options strategy such as deferral, and at the optimal time when profits are maximum, the upside potential can be capitalised upon by developers. Therefore, real options technique is valuable in real estate project evaluations because it derives superior results as compared to the DCF technique.

Given that the results of the real option valuation is positive, the project should be accepted and deferred over a period until when the payoff exceeds the option value. Thus, the real option value of AUD$290,000 today is not high enough to justify giving up the value of waiting to invest and commencing development today. This flexibility to defer a project and commence later when market conditions are favourable was ignored by the DCF framework. The results from the appplication of the real option model suggests that such contingent decisions would be made by developers as uncertainty in market conditions resolve. The results

coupled with the transparent evolution of the binomial tree demonstrates to the developers the potential associated with the project for better decision making.

Figure 7 Real option values at respective states of the world and optimal decisions

J Periods *i* down moves	0	1	2	3	4	5	6	7	8	9	10	11	12
0	hold	hold	hold	hold	hold	**exer**	**exer**	**exer**	**exer**	**exer**	**exer**	**exer**	**exer**
1		hold	hold	hold	hold	hold	hold	hold	**exer**	**exer**	**exer**	**exer**	**exer**
2			hold	hold	hold	hold	hold	hold	hold	hold	hold	**exer**	**exer**
3				hold	hold	hold	hold	hold	hold	hold	hold	hold	**exer**
4					hold	hold	hold	hold	hold	hold	hold	hold	hold
5						hold	hold	hold	hold	hold	hold	hold	hold
6							hold	hold	hold	hold	hold	hold	hold
7								hold	hold	hold	hold	hold	hold
8									hold	hold	hold	hold	hold
9										hold	hold	hold	hold
10											hold	hold	hold
11												hold	hold
12													hold

Source: Author, 2016

Naturally, these decisions would be taken by developers only if the *up* and *down* movements of the value and costs are realised in the real world as modelled. An important observation from the application of the real option model to this case study is that, developers should not abandon projects based on the results of a DCF model because it underestimates the value of projects. Rather, developers should explore opportunities for flexibility and evaluate projects based on their actual potential by considering the whole range of figures because that can improve decision making in property development.

In most cases, developers engage in presales before commencing residential developments. This obviously limits the ability of developers to delay projects because conditions within the purchase agreemnt may lead to purchasers cancelling presale contracts. However, in situations where developers have the potential to delay projects without legal consequences or cancellation of presale contracts, then the option to delay can be valuable in the financial evaluation of projects. The brown field development adopted in this case study is important in the sense that, project costs are escalated by cleaning of brownfield lands and demolition before commencing development. This naturally affects the potential profitability of development projects. As a result, this demonstrates the potential of real options method in capital projects evaluation even at the expense of escalated costs.

Recently, Vimpari and Junnila (2014) used the binomial option pricing model to evaluate the flexibility embedded in the divestment of a residential real estate fund that that had come to the end of its lifespan. It was found that the option to delay added about 6.6% to the total value of the apartments should the fund manager have decided to adopt the flexible strategy of selling the apartments. The certainty equivalence approach of the binomial option pricing model was adopted in a brownfield case study in this paper, making it different from earlier studies. The model uses the actual observable returns of real estate assets (rental yields, capital growth, and risk free rate) to calibrate the binomial tree and derive the results making it realistic.

5.0 CONCLUSION

The aim of applying the certainty equivalence approach of the binomial option pricing to a residential real estate development was to evaluate the applicability of real option models to practical case studies. The

option evaluated is the option to delay/waiting to invest which is generally used to determine the optimal timing of real estate developments and the value embedded in such flexibility. It was argued that the real option models are applicable to real life cases of real estate projects evaluation and that contingent decisions upon changes in market conditions must be factored into project profitability analysis.

It was found out that the main tool for real estate project financial evaluation (DCF) is unable to capture the flexible value embedded in the active management of projects such as a deferral strategy until uncertainty is resolved. The real option model however, provided a rationale for contingent decision making through the valuation of projects by considering a range of values rather than single point estimate. By doing so, the potential associated with projects can be holistically evaluated for better decision making in real estate developments. In this case study, a real option value of AUD$290,000 was found to be associated with the project which was missed by the DCF model. Therefore, property developers and analysts should acknowledge the value of waiting to invest in decision making concerning property developments.

It is unclear as to why developers and property practitioners do not acknowledge the value of flexibility in their project analysis especially when it adds value to the profitability analysis and enhances risk asessment by capturing the upside potential and limiting the downside losses. The certainty equivalence approach actually uses the real observable values of real estate developments in terms of returns, capital growth and rental yields to project the value evolution of real estate development values and risk neutrally calculates the potential value appreciation over the deferral period from the range of possible values. The transparency of the binomial tree coupled with the range of values provided the developers of this case study and analysts of the project with a better understanding of the future possibilities concerning profitability of the project and possible implications on the property development decision.

Finally, the choice of whether to start the development in the middle of the defferal period when the current pay off is greater than the real option value or waiting until the end of the period when the value is highest is dependent on the developers and the implications of the decision, though it is imprudent to keep holding onto options that are optimal to exercise. In some cases, unnecessary delays may create a situation where clients who might have purchased some of the units off plan may lose interest leading to cancellation of presale contracts. However, should the developers have the chance to hold onto presale contracts until the end of the 12-month deferral period, the construction should only begin at the end of the waiting period because the value of the option is highest and optimal at that point, which is a characteristic of an American call option that should not be exercised earlier than the maturity date. Naturally, these decisions will be made by developers depending on their risk profiles and ability to hold on to projects until either the optimal time for construction or the maturity of the option is reached.

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