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Staging Option Application to Residential Development: Real Options Approach

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1.0 Introduction

Property developers are still grappling with uncertainties in the financial evaluation of residential property developments. Financial feasibility evaluation of residential property developments is vital in any real estate development activity, because without an appropriate numerical measure of the potential future payoff from a proposed residential development, rational developers and investors are assumed not to commit to property development projects. In practice, the most widely accepted method of financial feasibility evaluation is the discounted cash flow technique (DCF) (Shapiro *et al.*, 2013). However, the use of uncertain input variables in the DCF method in determining the future payoff from property development, results in uncertain valuation (French and Gabrielli, 2004; French and Gabrielli, 2005). The DCF method has particularly been criticised by several leading authors, see for example (Dixit and Pindyck, 1994; Dixit and Pindyck, 1995; Hayes and Abernathy, 1980; Hodder and Riggs, 1985; Myers, 1984). Whereas Sirmans (1997) suggested that DCF is insufficient for evaluating capital intensive projects, Myers (1984) argued that DCF fails in strategic applications where future values of assets embedded in tomorrow's opportunities are tied to uncertainties. Trigeorgis (1993a) indicated that any attempt to ignore changes in input variables as a result of uncertainties or use DCF to evaluate tomorrow's opportunities from flexibility leads to serious errors.

Uncertainties that exist in property development pose considerable risks to developers in the form of unfavourable changes in economic conditions. One strategy adopted by residential property developers engaged in land banking in Australia against future unfavourable outcomes due to uncertainties, is the use of presales before commencement of construction. Developers primarily, use presales as a risk management tool to mitigate potential downside risks from uncertainties because they have not accepted the idea that uncertainties can have positive impact on profitability. However, presales can cause loss of future revenue to developers if residential property prices rise in future albeit locked in contracts, and when property values plummet, the potential of losses is also imminent as default in settlement may occur. In view of this, residential property developers require strategies that can deal with uncertainties better. For example, discussions with developers suggest that the most difficult variable to estimate accurately in financial evaluation analysis is value on completion.

Comment [KM1]: Deleted unsubstantiated sentence

Managing uncertainties in residential developments require active decision making in the form of inherent strategic alternative decisions that, can serve as both a hedge against future unfavourable outcomes and at the same time enable property developers to capitalise on emerging opportunities when market conditions are favourable. The value of such strategic flexible future decision rights are generally tied to uncertainty and the ability of developers to flexibly respond to changes in economic conditions during the execution of projects. These managerial flexibilities or strategies have been termed as options (Myers, 1984) and categorised to include defer, expand, stage, abandon, temporary shut down and compound options in real estate (Lucius, 2001) based on a general categorisation (Trigeorgis, 1996).

The real option to stage a residential development project is a common flexible managerial right a developer can adopt to mitigate future risks and uncertainties, while at the same time retaining the right to capitalise on emerging upside opportunities. Staging a residential project means a developer of a residential project can commence construction of a specific phase of a development as and when market conditions are favourable, and delay or possibly abandon a phase that is unprofitable later in the process of development. Thus, the potential value of a residential property development is contingent upon specific situations occurring in the respective property market at different stages of the development process. In view of this, Zardkoohi (2004) for example argued that real options are toehold investments and since DCF fails in strategic applications because of inability to evaluate tomorrow's opportunities (Myers, 1984), it is vital to adopt real options in the valuation of future opportunities. In fact, Myers (1984) posits that options valuation could be used to complement DCF valuation as an attempt to link together financial and strategic analysis. Trigeorgis and Mason (1987) and Dixit and Pindyck (1995) have all stressed the importance of incorporating and evaluating tomorrow's opportunities as a way to demonstrate the positive impact of uncertainties on the future payoff from capital investment projects.

Despite the potential of real options analysis (ROA) and real options valuation (ROV) in evaluating managerial flexibilities in capital intensive projects under conditions of uncertainties, real option valuation (ROV) still lacks practical adoption. Again, the option to stage/phase residential property developments has not been given prominence in the academic literature. For example, Bennouna *et al.* (2010) recently found that only 8% of respondents from a list of 88 large firms in the US are using real options. Chiefly among the reasons given is the sophistication and difficulty of the models used in determining real option values embedded in capital intensive projects and the lack of evidence of its practical applicability (Lander and Pinches, 1998; Oppenheimer, 2002). As a result, Geltner and de Neufville (2012) suggested that there is the need to apply the real option models to case studies in practical settings in different contexts to demonstrate the usability and applicability of the real option models in practice.

This paper adopts the newly developed but practically adaptable fuzzy payoff method (FPOM) to evaluate the option to stage a large scale residential property development project in Australia with the aim to demonstrate the practical usability of the real options models and to give further evidence needed for the adoption of ROV in practice. The originality of this paper is in the use of the newly developed FPOM, which has yet to be tested on the phasing/staging option using a case study in a real life setting. The result of the application has the potential to justify the use of the real option models for property development financial feasibility analysis and deliver better results than the DCF.

2.0 Literature Review

The real options theory has its roots from financial options and gained popularity after the development of the Black-Scholes option pricing model (Black and Scholes, 1973). Copeland and Antikarov (2001) suggest that an option holder has the right but not the obligation to exercise an option (defer, expand, switch, abandon, temporary shutdown) until its expiration date. In financial options, the future value of an asset is calculated from a range of figures to capture all possible future payoffs due to uncertainties. A similar logic is applicable in residential property development project where a developer has the right but not the obligation to commence development or defer until such a time imposed by either planning permission or contractual obligations.

As in financial option theory, a similar range of values can be generated for the determination of future property values and a single numerical figure calculated to represent the possible future payoff for a residential development for decision making. Since the decision to execute a project in property development is based on the single numerical figure (Vimpari and Junnila, 2014) that represents the possible future payoff from developments, the use of a range of values (distribution) can capture all future possibilities, hence accounting for uncertainties much better than single point estimates of DCF. French (2011), Byrne and Cadman (1984) have suggested that dealing with uncertainties in the real estate sector requires the use of a range of property values to calculate the single numerical information required for decision making.

Hoesli *et al.* (2006) adopted Monte Carlo simulation which uses a range of values (distribution) to capture uncertainties in valuation. Atherton *et al.* (2008) also used Monte Carlo simulation but in the evaluation of a specific real estate development case study and discussed that, significant improvements can be made to normative models when a range of values (distribution) is used in evaluating the profitability potential of developments. Their conclusion was that analysts must conduct a deeper analysis of uncertain variables in a valuation model to develop a better understanding of the implications of uncertainties in decision making in property developments.

In the real estate sector (land development), Titman (1985) was the first to apply the real option theory to a practical real estate case study. Quigg (1993) indicated that the present land valuation models need to account for optionality (wait) before investing. Chiang *et al.* (2006) used real option analysis and valuation to identify embedded options inside vacant land development and argued that the DCF cannot evaluate real options. Clapp *et al.* (2012) valued the redevelopment option in existing buildings under cyclical conditions. Vimpari and Junnila (2014) evaluated the option of waiting to invest in the divestment of a residential real estate fund. 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 the 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 ten 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 show a positive mean option premium value of +5.27% in the selected cases. 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. Pricing of options in leases has also been explored using the real options framework. A generalized option pricing model was developed by Grenadier (1995) for pricing a wide variety of leasing contracts including the option to cancel, forward leases and lease insurance contracts. One common clause, "an upward only review" in UK leases has also been evaluated through the options framework (Ward and French, 1997; Ward *et al.*, 1998). Using a multi-period binomial option pricing method, Sing and Tang (2004) examined the default risk options in office leases whereas Sing (2012) evaluated embedded options in percentage lease agreements in the retail sector.

Comment [KM2]: More recent literature added as suggested by both reviewers.

Another area of real options application is in building flexibility and adapting a building to suit changing conditions in property market. Greden *et al.* (2005) evaluated the flexibility of converting a naturally ventilated building into a mechanically ventilated building. de Neufville *et al.* (2006) applied it to an expansion option in a parking garage case study and found the flexibility provided by building small (a garage case sequentially) initially with the option to expand later adds 5% to the total initial construction cost but increases the expected economic value of the asset. Dortland *et al.* (2012) studied different kinds of flexibility in a health-care real estate project and Cardin *et al.* (2013) demonstrated that design flexibility has practical implications on the real estate industry. The current study differs from these earlier papers in respect of the area of application because it focuses on evaluating the value of flexibility in staging/phasing a residential project as a development strategy for evaluating financial feasibility.

The body of knowledge on the options pricing techniques and application to cases in real life settings in the real estate sector is still growing. Earlier research has focused largely on definitions and developing models for pricing of embedded options without the empirical evidence to support the application of the theory in practice. As a result, literature on the value of staging real estate projects is quite limited. Rocha et al. (2007) determined the optimal staging strategy whether sequential or simultaneous for the development of a residential housing project in Rio de Janeiro. They concluded that the sequential strategy option resulted in an upsurge of the value of the project by 10% while limiting the exposure to risk in excess of 50% as compared to standard evaluation methodology (DCF). Guma *et al.* (2009) using four case studies in the US demonstrated the potential value of vertically phasing a corporate real estate building. The study found that, vertical phasing is valuable because it is capable of limiting downside risks of corporate organisations when there is need for future expansion to meet the needs of an expanding organisation. The study sought to create the attraction needed to drive flexible expansion real options in practice but did not evaluate to determine the single numerical information needed by an analyst to make a decision. Quite recently, Geltner and de Neufville (2012) demonstrated the value of horizontal phasing of an urban real estate development project using the certainty equivalence approach of the binomial option pricing method combined with Monte Carlo simulation analysis.

Even though some earlier research has been done on the staging option in different real estate markets with different case studies, generalising those results to fit different property markets can be erroneous. Furthermore, the real option model adopted in this paper for the staging option is also different from the widely used binomial option pricing method. The binomial option pricing method requires the computation of volatility to represent uncertainty in the generation of the range of values, however, the model adopted in this paper uses scenario planning approach which does not require the computation of volatility making it simpler in application. Besides, scenario planning is a familiar method of representing uncertainties in the property industry, hence analysts and stakeholders may be able to relate with the method without difficulty.

3.0 Data and Description of Project

3.1 Methodology and data

This paper uses a quantitative approach based on a newly developed ROV model referred to as the fuzzy pay off method (FPOM). The FPOM uses different NPV scenarios based on scenario planning approach in financial evaluation to determine the value of flexibility embedded in capital intensive projects. The FPOM takes its root from the Datar-Mathews method (Mathews *et al.*, 2007), which uses probabilistic approach to compute real option values from a pay-off distribution of NPVs generated from Monte Carlo simulation. The treatment of uncertainty using probabilistic approach in the Datar-Mathews method was replaced by fuzzy set theory (Zadeh, 1965) to treat uncertainty in the FPOM as proposed by (Collan *et al.*, 2009). The idea was to reduce uncertainties to fewer scenarios that is manageable in practice.

In the fuzzy set theory as proposed by (Zadeh, 1965), different propositions or scenarios have a degree of membership in a set, i.e. membership is 0 (complete non-membership), 1 (complete membership) or a value between 0 and 1 (an intermediate degree of membership). Based on these three types of degrees of membership in the fuzzy set theory, uncertainty was easily projected by Collan *et al.* (2009) in three scenarios: minimum, most likely and maximum. These scenarios are usually used in investment analysis in the real estate and construction sector making it transferable. The three scenarios are treated as triangular fuzzy numbers in the FPOM and form a triangular pay off distribution. In the triangular pay-off distribution, the most likely scenario is given a complete membership, the minimum and maximum scenarios are given complete non-membership, and other scenarios between have intermediate degrees of membership. Based on the information on the scenarios and degrees of membership, a triangular pay-off distribution that is "a graphical presentation of the range of possible future pay-offs the investment can take" is deduced (Collan *et al.*, 2009). The real option value (ROV) for staging the development is calculated from the distribution or range of values. The ROV using the FPOM is given by

Comment [KM3]: More discussion on methodology as requested by Referee 1

$$ROV = \frac{\int_0^\infty A\,(x)dx}{\int_{-\infty}^\infty A(x)dx} \times E(A_+) \qquad Equation\ 1$$

Where

A= the fuzzy NPV,

$E(A_+)$ = the fuzzy mean value of the positive side of the NPV,

$\int_{-\infty}^{\infty} A(x)dx$ = the area below the whole fuzzy number A and

$\int_{0}^{\infty} A\,(x)dx$ = the area below the positive part of A. For a graphical presentation and further detailed description of the method and other mathematical formulas, see (Collan, 2012; Collan *et al.*, 2009).

In view of this, three NPV scenarios were calculated using the project's cash flow and cost projections. These scenarios are minimum NPV, most likely NPV and maximum NPV scenarios. In generating the NPV scenarios, a 10 year time series data (2006-2016) covering more than one property cycle on the capital growth of town houses and units in a residential apartment building were divided into different quartiles; upper, lower and median quartiles. It is assumed that a 10-year range of data is sufficient to capture price variations over a period within the property market. The upper, lower and quartiles were used to compute the maximum, most likely and minimum NPV scenarios for each year from 2010-2016 which is the duration for the development for all the different types of town houses (different number of bedrooms and bathrooms) and units (different number of bedrooms and bathrooms in different medium density buildings) in the proposed development for the FPOM evaluation of the staging option. For example, there were 23, 74 and 26 of 5, 4 and 3 bedroom houses respectively. Similarly, the units in the medium density apartment buildings were also diverse with respect to the number of bedrooms and car parks. The reason for the use of capital growth as proxy for value evolution is because it is a measure of change in property values annually and the average of a series represents the potential future growth in real property values beginning from the year 2010 when the project was at the inception stage. This also ensured consistency because the project was scheduled to begin in 2010 and any financial evaluation analysis must step back in time to 2010 in order to do a realistic financial modelling that mimics conditions in the real estate market at inception stage of the project for proper financial evaluation. In Table 1, the different quartile values for the different NPV scenarios are displayed. It reveals quartile values for town houses and units ranges from a low of 3.95%-10.45% and 3.28%-14.55% respectively. As can be seen, the values are also grouped into the different quartiles for the generation of the triangular distribution.

Comment [KM4]: Since the business cycle is inextricably linked to the property cycle, 10 year period being more than one property cycle is justified as stated by Richard Reed, Hao Wu, (2010) "Understanding property cycles in a residential market", Property Management, Vol. 28 Issue: 1,pp. 33-46, doi: 10.1108/02637471011017163

Comment [KM5]: Statistics already shown in Table 1 as requested by Referee 1

Table 1 Located here

Similarly, the cost was also assumed to increase yearly due to the staging/phasing of the development. In practice, contract sums in the construction industry in Australia can be indexed to different measures including consumer price index (CPI) and construction libor rate. The CPI was chosen because it is the most commonly used measure in practice to index against uncertainties during the period of construction and also had higher values than the construction libor, thereby capturing higher uncertainties for all possibilities. Using data spanning a period of 25 years from 1990-2016 (to capture cyclicality), the lower, median and upper quartiles were calculated to be 2.99%, 4.38% and 5.75% respectively. The lower, median and upper quartiles were used to generate the minimum, most likely and maximum cost scenarios respectively for the ROV.

Comment [KM6]: Some statistics shown here as requested by Referee 1

Based on information from the developer, total estimated cost and revenue were about $122million and $152million respectively spread over a period of 5 years. A discount rate of 10.23% was calculated as weighted return from a 10-year average return for investments in houses and units within the locality (North Melbourne) where the project was located. The weighted return was used to ensure representation for both units and houses in the development. A cost discount rate of 2.5% (long term inflation target of Reserve Bank of Australia (RBA)) was also used to discount the cost for the computation of the NPV. Table 2 shows the different weightings for town houses and units and their respective rates of return. The weightings and returns are used to compute the weighted return for the whole development. It can be seen that the rate of return is calculated to be 10.23% and used in the DCF modelling.

Comment [kM7]: Clarified the city where the project is located and the rate used is the prevailing rate as well as in the region of the rate used by the developer -Referee 2

Table 2 Located here

3.2 Case Study and Data

The large scale urban residential development is a complex project located in the eastern part of Melbourne close to a highway that links Melbourne CBD to eastern suburbs of Melbourne. The site for the residential development is approximately 36,000m^2 with all important amenities including a University, shopping centre, Tram and bus stops needed for a successful housing development all available to drive occupier demand. The development comprised of approximately 240 accommodations, 50% delivered within four medium density buildings and the balance as houses on different blocks of land sizes.

Comment [KM8]: Figure 1 not needed so deleted as requested by Referee 2

The project began in the year 2010 and took four years to complete in 2014. Discussions with the developer reinforced the assumption that the project was expected to proceed at once without any optionality or flexibility to alter course when the need arises in future. Therefore, the total cost of the land was paid at the commencement of the project without considering any optionality or flexibility to abandon some phases of the project when the need arises in future. The financial evaluation analysis also conveyed similar features as there was no in built strategy to deal with changing economic conditions in the property market during the execution phase of the project. Thus, the evaluation assumed a static approach to the residential development, whereas the developer suggested that he actively managed the project until completion.

To perform a more realistic model that mimics the reality of the development, it is suggested that the developer stages the project by dividing the development into 4 phases over 6 years to complete in 2016 with intentional delays after completing each phase for uncertainty resolution before proceeding with the next phase. Thus, after completing each phase, the developer uses the following year to analyse the market and ensure that uncertainties are resolved before commencing the next phase. As a result, the developer is assumed to be rational and will not commence a phase when there is uncertainty surrounding a specific phase of the project. This flexibility is valuable in real estate development and must be accounted for in valuation in addition to the deterministic DCF value in order to produce the right numerical information for decision making. Therefore, the modelling assumed a starting point in 2010 and completed in 2016 and compared to the value derived by the DCF method which used a single phase development approach for the financial evaluation based on which the developer executed the project.

Obviously, the options on the land adopted by this case example seek to push considerable risks to the land vendor. Naturally, the vendor would seek higher land value than an outright purchase because of extra holding cost for each period of delay, potential increases in land value during delay of phases of the development and a value for the option for the vendor to hold the land for the developer. Thus, the developer will forfeit the amount paid for the option in the event of abandoning some phases of the development due to unfavourable market conditions. Using data provided by the developer, a cost of $344,288 was calculated to be the extra holding cost which the developer must bear in delaying some phases of development by extending the timing for two years. The potential increase in land value during delay has already been factored into the stochastic evolution of the cost over time in calibrating the three scenarios. The cost of the option is assumed to be 5%, 10% and 15% of the land value for the three scenarios respectively. This results in a total extra cost of $1,469,288, $2,594,288 and 3,719,288 for the minimum, most likely and maximum scenarios respectively.

Comment [KM9]: Extra cost to be borne by the developer due to intentional delays of phases of the project and the option placed on the land for the phased development as requested by Referee 2.

4.0 Results and Discussion

The large scale residential development was first evaluated using the DCF technique and sensitivity analysis was performed using Top Rank software of decision suite, which is recognised industry software to determine the impact of uncertainties of variable inputs on the final profitability of the development. The FPOM model of real options theory was also used to evaluate the development based on a staging strategy and compared the results from both applications. Results from the application of the DCF technique using 10.23% (weighted average of returns on investments in housing and units in the location of the development) discount rate suggested that, the present value of the profit potential would have been $10.6million, signifying about 8.7% development margin on the undiscounted cost. This level of profitability is deterministic in the sense that it assumes conditions in the market will stay steady until completion of the large scale residential development project.

Comment [KM10]: Explained how sensitivity analysis was performed as suggested by Referee 1

However, a sensitivity analysis of the impact of potential changes in uncertain variables such as a rise in discount rate to 20% for revenue and 5% for costs, suggested the NPV would have been $-2,069,925!. Thus, the developer would have incurred losses should such a scenario have occurred during the execution phase of the project without any flexible strategy to salvage the project. Thus, without considering all possibilities and developing a strategy to deal with uncertainties, unfavourable changes in uncertain variables could have had serious financial consequences on the project. Therefore, a more realistic model of evaluation of such a large scale urban residential project was staging the development in phases where some of the phases could have been abandoned due to unfavourable market conditions or expanded due to emerging upside opportunities over time during the financial evaluation in order to make an informed decision.

Table 3 displays the results from the FPOM application in evaluating the large scale residential development project based on a staging option. The results in Table 3 reveal that all conditions prevailing, the mean NPV would have been $14,481,652 which is greater than the results derived from the DCF application even though the options framework has an added costs to reflect the risks associated with the optionality analysis. The ROV which captures the value of the flexibility of being able to abandon some phases of the project whiles retaining the potential upside gains is computed to be $13,949,148 which is also greater than the value obtained through the DCF application.

Table 3 Located here

One reason that could be assigned to the difference is the value in uncertainty where changes in property values over time can have an added value. Therefore developers who sign presale agreements for entire development projects before commencement without considering the potential of future opportunities through the stochastic evolution of residential property values and retain the right to capitalise on them are missing out on the added value of flexibility in practice. Even though the results from both DCF and FPOM are positive, the FPOM delivers higher profitability because it is able to incorporate potential future upside possibilities/opportunities in the valuation, making the valuation of the large scale residential development more realistic and with higher potential of viability.

Comment [KM11]: Added a phrase to qualify the sentence for clarity and fine tuning of the argument.

Despite the FPOM embedded with a staging option offering superior results than developing the whole project at once as assumed by the DCF framework, the importance of presale in risk mitigation in the DCF for example cannot be discounted. In terms of risk mitigation, presales allow developers to secure potential purchasers before construction begins, thereby eliminating risks of lack of demand after completion though defaults at settlement could still occur. It also serves as a requirement for attracting debt funding from commercial financial banks and reduces borrowing costs for the project in question. Deferring some of the presale contract agreements with prospective occupiers in order to capture the value associated with upside opportunities if there was enough equity to begin the project could have ensured higher profitability in a market where property values are on the rise. Better still, if due to requirements of debt funding there was the need for presales as is prevalent in practice, a flexible contract that allowed the developer to make upward adjustments to the initially agreed value of the individual properties during presales in line with current market prices after completion would have been plausible in order to benefit from the future upside opportunities.

Comment [KM12]: Cost-benefits of presales, impact of maintaining options in early stages and potential costs, upside gains and capping of potential losses.

Even though this proposal of maintaining options on the land at the early stages of the development has considerable risks of increased costs, paying this amount to cap downside losses is better than the full impact from potential unfavourable market because, in the event of defaults at settlement of a specific phase of the development, the risk is limited to the losses at that specific phase. Thus, holding costs and cost for the option of holding onto the land may be far lower than the potential losses that would have been incurred in the event of developing the entire project at once. Moreover, in an unfavourable market, potential decline in land values could also be averted with the optionality analysis.

Comment [KM13]: Further comments to clarify the argument of the phasing development

Comment [KM14]: Updated Figure after reworking with the data

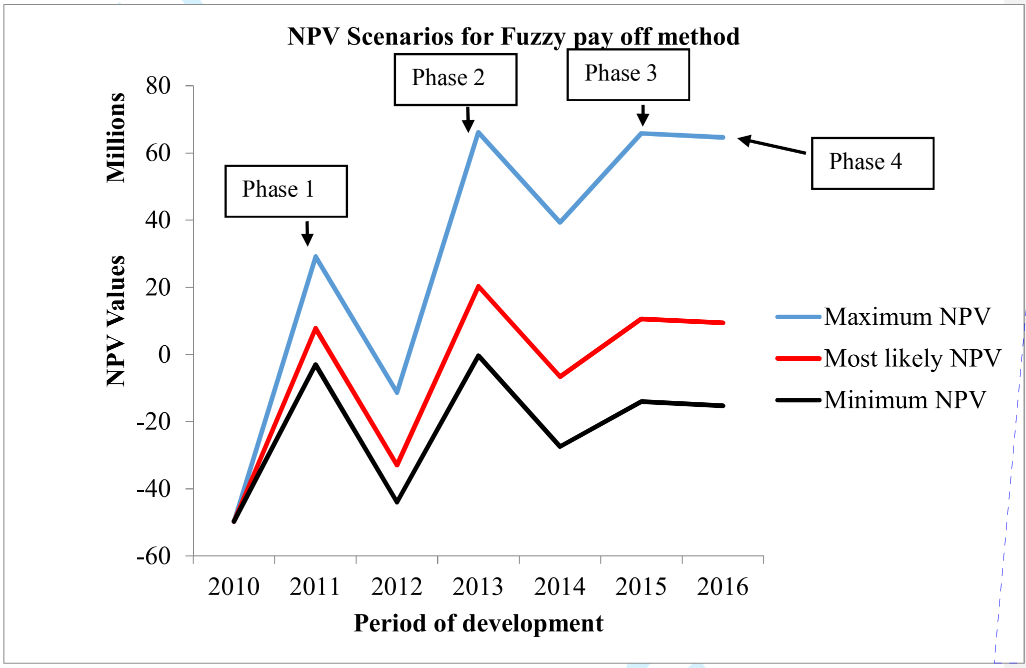

Figure 1 Graphical presentation of NPV scenarios for FPOM

Source: Authors, 2016

Figure 1 graphically illustrates the three NPV scenarios for the residential property development project for the ROV computation using FPOM. It is evident the cumulative NPV path for both best guess ($9,385,647) and maximum scenarios ($64,621,216) are above zero over the entire four phases of the project indicating that the project will financially be successful, should conditions in the market be favourable. However, the cumulative NPV for minimum scenario ($-15,273,894) is negative for all four phases, indicating that the project is bound to make losses in an unfavourable market. Even though the minimum scenario suggests that the project is bound to make losses, the combined effect of the maximum and most likely scenarios ensure that the mean NPV computed from all possible values including the minimum scenario, is positive to result in a profitability potential for the project. Thus, indicating to the developer to execute the project due to the potential upside gains associated with the project. Because the developer is able to limit the quantum of capital sunk into the project at different stages of the development, the staging option limits the possible downside losses when faced with a minimum scenario. However, the upside potential remains open and can be capitalised upon at any time during the life of the project.

Comment [KM15]: Figure changed to reflect the changes after reworking with data-Referee 2

Comment [KM16]: Figure changed to reflect the changes after reworking with data-Referee 2

Comment [KM17]: Figure changed to reflect the changes after reworking with data-Referee 2

The mean NPV of $14,481,652 realised from the application of the FPOM is a significant improvement on the values realised from the DCF technique. The mean NPV from the FPOM considered all possibilities including the maximum, best guess and worst possible future NPV

Comment [KM18]: Figure changed to reflect the changes after reworking with data-Referee 2 values of the large scale residential development in the form of the triangular pay off distribution and computed a single numerical measure of the profitability potential of the residential development project. This single numerical measure is indicative to the developer or a decision maker, how the other values (all possibilities) are distributed around the best guess estimate. In this case, the payoff distribution is asymmetric and there is skewness to the positive side of the triangular distribution, hence the mean value being positive and higher than the best guess estimate. This suggests that, the profitability potential of the residential development is much higher than the potential loss.

The ROV is calculated to be $13,949,148 representing 11.40% on the undiscounted cost of the residential project resulting in an option premium of about 2.7%. The real option value represents the potential of the project to be profitable through the use of the flexible strategy of the staging approach to the project rather than executing the whole development at once as assumed under the DCF approach. This demonstrates the value in the flexibility embedded in the staging strategy for the residential development. Through the staging, developers are assumed to initiate development of phases that are profitable and abandon phases that are unprofitable. It is this form of strategic analysis combined with a specific stochastic process in the form of different scenarios for the financial evaluation that renders the DCF unrealistic in its approach to evaluating staged investments. As a result, the staging allows the developer to mitigate losses that are imminent in future during the process of development. The FPOM realistically modelled this flexibility and incorporated them in the valuation rather than assuming a static approach to the management of the development project.

Comment [KM19]: Figure changed to reflect the changes after reworking with data-Referee 2

Comment [KM20]: Figure changed to reflect the changes after reworking with data-Referee 2

Comment [KM21]: Figure changed to reflect the changes after reworking with data-Referee 2

The FPOM relies on fewer scenarios as a representative to project uncertainties and this analogy has been recognised by (Cardin *et al.*, 2013) as a way of ensuring practicality of uncertainty assessments in design flexibility. The three scenarios in the FPOM are illustrative of a range of likelihoods plausible for analytical purposes in practice, and broadly sufficient to aid a more informed analysis of financial evaluation of phased developments in general and risk management thereof. As the scenarios are fewer, it enhances the practical usability of the model for financial evaluation as compared to a wider distribution that may not be manageable by practitioners in practical applications. In the FPOM, the valuation of option values are fused into the different scenarios resulting in a payoff that captures salient possibilities resulting from uncertainties. Even though similar scenarios could be generated using the DCF framework, the scenario values achievable are not factored into the computation of the single numerical value representing the future payoff of the investment in the DCF framework.

Comment [KM22]: Further discussion on practical significance –Referee 1 and 2

As indicated earlier, there is growing attention of literature on real options. Mostly, models adopted in evaluating case studies are based on probability analysis and differential equations (Black-Scholes model and Binomial Option Pricing Method), which has been deemed difficult to apply and mathematically complex. In the FPOM, the projection of uncertainty in three scenarios without the necessity of probability analysis and computation of volatility seems to produce a simple and straightforward tool for calculating ROVs. Similarly, the adoption of NPVs for all three scenarios as input values in the financial evaluation of the project resonates with practitioners. Since practitioners are familiar with scenario analysis, it can facilitate adoption of the FPOM in practice quicker than the other mathematically complex models. Moreover, using FPOM does not require special expertise in practice. Based on expert judgements and approximations, the different NPV scenarios can be calibrated in excel and ROV computed. Because the FPOM is readily adaptable by way of using data from DCF including NPVs from the different scenarios as input parameters, it increases the practical appeal and usability of the method. To this end, the FPOM, if given prominence in the literature especially in practical case study applications, has the potential to achieve practical adoption.

Comment [KM23]: Potential for practical usage of the method as opposed to other ROV methods –Referee 1

Comment [KM24]: Further discussion on the possible choice of ROV model for practical adoption-Referee 1 and 2

In this paper, the focus was on the staging option embedded in a large scale residential real estate projects. It basically reflects the risks associated with the staging option in the sense of increased costs during the phases when the project is delayed pending the resolution of uncertainties. There is therefore risk mitigation through the staging strategy because the developer is assumed not to initiate the development of a specific phase unless it is profitable. Besides, the developer in reality can exercise the option to contract the scale of the project if market conditions warrant so. Thus, the losses are capped to the cost of the option used to secure the land until the delay period lapses. In this case, the risk is passed on to the vendor in lieu of payment received for the option of holding onto the land by the vendor for the developer. On the other hand, the upside opportunities associated with the staging option cannot be overemphasised because during the period of delay, the value can reach up to the maximum value possible, leading to higher than expected profits. Some specific phases of the project can also be expanded to capture rising demand for residential properties if market conditions are favourable. The results for this project and the risks considered are obviously limited to the adopted flexibility; staging option. The risk profiles examined in this paper relates to variability in the value of the development on completion due to uncertainty resulting from market forces. It is possible that projects with different risk profiles and uncertainty sources may deliver different results using the FPOM. Similarly, a different flexible strategy such as expand or defer with a different dataset from a different city in Australia can also result in new findings. Even though the strategy adopted for this case study has been effective and delivered results superior to the DCF, any analysis must be done on case-by-case basis because, different real estate projects have unique risks and characteristics, and it is possible that different real option strategies may produce different results.

Comment [kM25]: More on practical implications-Referee 1 and 2

For practitioners both in Australia and around the world, this may be a new tool/technique for evaluating the profitability of property developments coupled with the use of staging strategy. It is accepted that property practitioners are conservative in their approach to analysing profitability and risks. However, it is important for property practitioners and other property decision makers to note that, the volatile nature of property markets in the 21st century presents both risks and opportunities that are highly unpredictable and require flexibility to adapt to uncertainties as events unfold in property markets. It is the flexibility to delay, stage, expand, switch, temporary shutdown or abandon a project that has the potential to mitigate downside losses while retaining the positive potential of real estate projects. Moreover, it is a realistic approach to evaluating projects because rational developers do not execute projects knowing that a project is bound to fail. The reality is that there is no accuracy in predicting the future values of real estate values, but, through these flexible strategies developers can best prepare against unforeseen risks and uncertainties in property development and deal with them as they unfold.

The FPOM can be extended to other options embedded in real estate projects such as switching output, expand, defer, abandon, and temporary shutdown which have yet to be evaluated using this new methodology. Since the FPOM resonates with practitioners and uses DCF results as input data, it has the potential to become the model for practice and as such should be explored further on other case studies in the real estate sector. Further research can be applied to case studies where developers build and hold the assets as part of their portfolios. The case study was a development that had presales incorporated in the revenues. It will be interesting to see the results of ROV using rental projections as revenues and compared to DCF evaluation. Also, in this case study, the scenarios were generated using capitalisation rates from the location of the project. It is possible to find different means of representing the uncertainties other than the use of capitalisation rates. Lastly, since this was a private project, the method can be tested using data from a corporation, which is developing for example an office for their own corporate use.

Comment [kM26]: Potential for practical usability as requested by Referee 2

Comment [KM27]: Moved it from conclusions to discussion of results to improve the paper-Referee 1

The findings of this case study application is similar to findings from studies conducted by leading authors (Geltner and de Neufville, 2012; Guma *et al.*, 2009; Rocha *et al.*, 2007) in real estate development using case studies from elsewhere in the world. The major difference between this research and earlier research is in the real options method that was adopted for the evaluation of the real estate project and the type of option evaluated. The real options method used by all the leading authors in evaluating a staging real option involved the assignment of probabilities, use of Brownian motion and computation of volatility to represent the different uncertainties in the specific case studies. For example, both Guma *et al.* (2009) and Geltner and de Neufville (2012) used Monte Carlo simulations combined with binomial lattices which requires the computation of volatility. However, the use of the FPOM did not require the computation of probabilities or volatilities to generate the distribution of values for computing the profitability of the project. It adopted scenario planning approach which is already known in industry, making the application very direct and simpler for practitioners.

5.0 Conclusion

The main purpose of applying real option analysis and valuation on a case study was to empirically evaluate the applicability of ROV to a real world property development case study. The results derived from the application using FPOM on the staging option of the large scale residential project supports the argument that ROA and ROV are able to quantitatively derive numerical information for valuing staging flexibility embedded in real estate projects for decision making in practice. The use of ROV method enhances the evaluation of projects and delivers superior results because it captured about 2.7% of the value of managerial flexibility that was missed by the DCF technique. This study provides the evidence of the technique's applicability to real world problems in real estate and construction sector.

Comment [KM28]: Figure changed to reflect the changes after reworking with data-Referee 2

A major theoretical contribution of this case studies to the real options literature is the demonstration that FPOM and by extension, ROV models are applicable in property development financial feasibility analysis. The originality of this application emanates from the use of FPOM, which has not been tested for its application to real life case study on the value of horizontal staging real option in real estate sector. This is in line with current research that seeks to achieve the practical adoption of ROV models in practice. The application also gives further evidence to support the use of ROV techniques for evaluating actual case studies in practice. Since the FPOM was found to be simpler, direct and transparent in its approach to the treatment of uncertainties in property development, it has the potential to be adopted in practice as compared to the other ROV models such as the binomial option pricing method which requires probability and volatility analysis.

An important observation from this application is that it recognises the potential uncertainty that might result from changes in market conditions and realistically models a flexible strategy to deal with such uncertainty as and when it occurs rather than myopically adjusting discount rates in an attempt to deal with uncertainties. Even though uncertainty sources may be numerous, the modelling of its potential impact on property values through the flexibility of phasing a project offers developers and other practitioners an opportunity to intelligently adapt to market conditions in order to deal with emerging issues. Such flexibility has value which has been demonstrated through the options framework and as a result, developers and practitioners must consider similar flexibilities at the inception stages and embed them in the design stage of a project.

Comment [KM29]: Further discussion on practical implications as requested by Referee 1 and 2

For practitioners in the property and construction sector, the ROA and ROV results using a scenario approach in the form of generating a distribution of potential property values in fewer scenarios is intuitive than a single point estimate from the DCF technique. The use of a range of values captured all the possible uncertainty (upside and downside) associated with the residential development project. Scenario analysis was merged into the valuation, which practitioners were quite familiar with, was also important for the practitioners who participated in this research. The indication was that the FPOM is transparent in the treatment of uncertainties, and calculating the single numerical information out of the range is certainly better than the deterministic single point estimate of the DCF. The method was also fairly straightforward and does not require the computation of volatility and the use of probability theory, making it easier to use which can enhance practical adoption in the property industry. The use of the DCF results as input data in the FPOM indicates that the method basically extends DCF analysis, thereby enhancing its practical appeal and usability because practitioners would not require any technically complex knowledge of mathematics before being able to apply them in practice. It can be argued that the FPOM has the potential to be practically accepted as opposed to other ROV models that have very strong quantitative requirements for practical application.

Comment [KM30]: Potential for practical usability of the FPOM by Referee 1

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List of Tables in the manuscript, captions and sources.

Table 1 Quartile capital growth rates

Quartiles	*Units*	*Houses*
Upper	10.45%	14.55%
Median	7.20%	6.70%
Lower	3.95%	3.28%

Source: Author, 2016 (Adapted from data provided by Core Logic RP Data)

Table 2 Discount rate computation (weighted return)

	Houses	*Units*	*Total*
Weights	65%	35%	100%
Return	10.68%	9.40%	20.20%
Weighted return	6.96%	3.27%	**10.23%**

Source: Author, 2016

Table 3 Results for staging real option using FPOM

Profitability measure	*Value*
Best guess NPV	$9,385,647
Mean NPV	$14,481,652
Real Option Value	$13,949,148

Source: Author, 2016