Real Options Analysis in Appraisal of Commercial Property Developments

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Abstract

Purpose: The objective of this paper is to demonstrate the application of real options analysis (ROA) to real estate development (RED) appraisal with the aim of enhancing real estate investment decision making.

Design/methods: Using data of three commercial RED as case studies, the study compared the results of the appraisal output of the traditional DCF(NPV) under three scenarios of most optimistic, most likely and most pessimistic, against the results obtained from the ROA using the Samuelson McKean formula. The study examined the options to delay development and vertically expand development.

Findings: The results showed that the use of the traditional appraisal models favours a stable and optimistic market; with positive trends and forecast. Thus, during unanticipated market downturns, investors might be exposed to the greater level of downside risk when RED investments are appraised based on the traditional models only. This implies the needs to encourage the adoption of a more flexible appraisal technique such as the ROA.

Practical Implication: The paper gives a further insight on the use of ROA in comparison with appraisal the traditional appraisal models.

Originality: From the perspective of an emergent market, this paper is one of the few attempts that seeks to demonstrate the practical application of ROA in practice.

Keywords: real options analysis, commercial property development, investment appraisal, Net Present Value, flexibility, internal rate of return

1.0 Introduction

There has been an increasing claim that outputs of investment appraisal in most emergent markets are often difficult to justify in real terms, unreliable and are often fraught with inaccuracies (Bannerman, 1993; Olaleye *et al.*, 2014). The lack of reliability and inaccuracies in real estate development (RED) appraisal apparently leads to investors' disenchantment with the appraisal process, and it might be expected that investors will undertake RED without recourse to appraising the viability of such projects or the available alternatives. Given that uncertainty is an integral part of the environment wherein the RED takes place, the economic forces must be understood well enough before the appraisal estimates can be accurately justified and reflect existing reality (Ayodele, 2017). Thus, it could be adduced that a major reason for the inaccuracy of these appraisal outputs stems from the high rate of volatility and fluctuations of input parameters employed in the investment appraisal. Generally, investment appraisals are conducted using either the traditional approaches, probabilistic models or other contemporary approaches such as real options analysis (ROA). While studies (see for instance, Yeo and Qui 2003; Carmichael, 2011) have raised criticisms against the adoption of traditional and probabilistic techniques in the appraisal of investment assets, studies (see Brealey *et al.,* 2012) have advocated the need to complement the outputs of these traditional techniques with other contemporary appraisal models such as the real option analysis. While the real options analysis should not be regarded as a silver bullet, it is expected that its adoption will enhance the reliability of the appraisal output. However, while literature (Block, 2007) suggest that ROA has gained appreciable grounds among real estate appraisers in developed economies, the adoption and use of ROA as an appraisal technique appears uncommon among appraisers in most emergent markets like Nigeria.

Over the life of an investment, based on changing markets indices and unfolding realities, modifications are made to the investment cash outlays which the traditional appraisal models will ordinarily not take into consideration. These unexpected changes introduce the need for some form of investment or managerial flexibilities to alter the course of the development. The utmost aim of the investor is to minimize the tendencies of a downside loss while opening up more avenues for an upside market advantage (profit). The exercise of flexibility often results in the adjustment of the investment outlay with respect to the timing, expansion/limiting the scope of the investment and other array of choices open to the investor. Thus, flexibility arises from the ability of the investor to alter the course of the investment; either before commencement (wait/defer), during the development (exit/abandon) or after construction, that is, during the operational phase of the investment (switch/growth). Thus, in the face of the changing market dynamics and high rate of volatility pervading most emerging markets and economies, the flexibility embedded in the RED investment is better appraised using the real options analysis. This explicitly accounts for the strategic investment decisions, which the traditional and/or probabilistic techniques do not adequately reflect in the evaluation of RED investment outlays.

Arising from the foregoing, this study seeks to empirically compare the appraisal outputs obtained from the traditional investment analysis and ROA based on case studies obtained from the Lagos property market.

2.0 Literature Review

Since the term real option was coined by Myers (1977), it has been applied to a vast array of fields and discipline; real estate inclusive. The work of Titman (1985) could be regarded as one of the pioneering works in the field of real estate. The study introduced the binomial real options model based on the work of Cox *et al.* (1979) in valuing a vacant land. The study rationalised the behaviour of landowners who defer construction/decision to invest on vacant lands with the aim of obtaining higher profits from the anticipatory increase in land prices. The study mathematically illustrated that the higher the uncertainty in the future rate of vacant plots, the higher the option value to delay commitments. Hence, the need to delay in the exercise of the existing option. McDonald and Siegel (1986) examined the optimal timing of investment in an irreversible project outlay. The project, executed within the framework of uncertainty in project value and costs. The study advocated for the use of real options valuation for projects under the constraints of irreversibility, value and cost uncertainty with a view towards maximizing investment returns.

Lucius (2001) analysed the relevance of real options framework in RED decision based on a desktop analysis of past studies. The study concluded that though there are extensive researches in the field of real options analysis, the results appear academic, abstract in nature and with limited practical value. The study concluded on the need for further research concerning basic prerequisites for real options pricing framework. Ford, Lander and Voyer (2002) assessed the effect of real options framework in valuing construction projects under strategic flexibility. The study adopted a case study approach, using a toll road project and applied flexibility scenarios to evaluate the decision pathways available to the construction team. The study noted that specific dynamic uncertainties can be adequately managed and their value captured by implementing flexible strategies. The study revealed that the adoption of real options techniques lead to potentially large improvements in construction management and the ability to manage uncertainty could also be regarded as a strategic advantage in construction management. Barman and Nash (2007) developed a model for estimating real option in RED under uncertainty using a case study approach. The study employed the traditional NPV model, the Samuelson McKean and the Monte Carlo Simulation methodology to calculate the option value inherent in the RED. The study developed a model for estimating project's relative risk and value with and without inherent options. The study concluded that the real options approach suggests that phasing the project represents the highest and best uses of the site. Though, the NPV model presented a clear perspective of the project risk exposure.

Pearson and Wittels (2008) analysed the effect of flexibility in the vertical phasing of commercial RED based on real options analysis. Using a case study approach, the study noted that though the vertical phasing of buildings is uncommon and intricate, it serves as a viable method of RED that has the potential to enhance the value of the development. The study concluded that given the success recorded in the vertical expansion, most investors that are previously wary of embarking on vertical phasing due to lack of verifiable examples, specific challenges attributed to vertical phasing and unfamiliar and uncommon in the RED industry, would readily embark on a vertical expansion of RED. Kim (2008) examined the impact of real option to mixed-use RED project, using Parc1 project in Seoul, Korea as a case study. Parc1 consist of two office towers, a hotel and a retail mall. The study employed traditional NPV analysis and Monte Carlo simulation method in its analysis. The study found that flexible valuation models performed better than the static traditional inflexible ones. The study found that identifying inherent flexibility in RED helps to realize the latent value of development projects. In a similar study, Guma (2008) assessed the application of flexibility in the vertical expansion of a RED at a future date. The study employed a Monte Carlo Simulation analysis and the traditional NPV calculation in determining the expansion of an existing structure to almost twice its current height. The study noted that the ROA provides valuable decision metrics that are important factors in decision making that the traditional NPV/DCF analysis would normally ignore. Hence, ROA enhances the ability of the investor to match their investment preferences to development projects.

Parthasarathy and Madhumathi (2010) adopted a case study approach in investigating the application of real option to the valuation of a commercial real estate mall project. In evaluating the role of real options analysis, the study comparatively analyzed the findings of the case study adopting traditional DCF with Black-Scholes, Binomial and Samuelson McKean option models. The study noted that real options analysis becomes germane when market prices increase the strategic value embedded in RED projects through fluctuations and flexibility. The study concluded that RED might gain a strategic return of 85% based on the value estimates of the Samuelson McKean model. Huimin and

Pretorius (2011) focused on evaluating the real option in residential development in Hong Kong. Employing the Samuelson McKean formula, the study empirically investigated the American call option model for long-dated land development option and examined if the model explained developers behaviour through its analysis. The study found an average option premium for real option in the Hong Kong RED market. The study concluded that in order to encourage real option practice and stimulate the interest of practitioners in the use of the real option, key variables involved in the analysis peculiar to each market environment must be clearly identified and clarified. This will make for accurate identification and description of the estimated real option value. Throupe, Sewalk, Zhong and Huo (2012) analysed the application of real options valuation in determining the optimal investment decision for a mixed-use RED in Denver, Colorado. The mixed-use building used as a case study incorporates apartment building, retail and parking lots. The study investigated the returns on investment if the construction goes as planned or the investor chooses to adopt a different property mix allowable within the local zoning codes. The study noted that real option valuation enhances risk management and provides an objective assessment of investment decisions by comparing and supplementing the traditional NPV approaches with the option pricing models.

Bravi and Rossi (2012) assessed the application of real option in determining the highest and best use of an industrial urban site. With the use of both binomial lattice model and Monte Carlo Simulation method, the study found that the option value was affected by the inability to obtain income before the end of the construction phase. The study concluded that though the binomial method appears inconclusive, the Monte Carlo Simulation was found more appropriate in valuing the real option embedded in the case study. Sattarnusart (2012) investigated the effects of real options in RED investment. The study employed traditional NPV, Monte Carlo simulation and sensitivity analysis on a case study commercial RED at Spitalfields, East London. The study showed that using the traditional NPV approach in investment evaluation often leads to wrong appraisal decisions about 90 percent of times. The study thus recommended a blended approach of both the traditional NPV and the real options with the aim of improving real estate investment decisions. Shen and Pretorious (2013) studied the option-pricing model on RED using the binomial option-pricing framework with the considerations of time to build and delay. The study also adopted sensitivity analysis in its assessment of these considerations. The study found that contractual covenants and firm's financial status are factors that contribute to project value and investment timing. The study concluded that real options analysis should emphasize industry-specific characteristics rather than individual options. Morano, Tajani and Manganelli (2014) assessed the application of real options analysis in the assessment of urban redevelopment of a former industrial real estate. The study noted that while the traditional NPV suggested that the project is abandoned, the binomial approach affords an approach that allows accurate monitoring of the project's development, thus the development progresses as the market evolves. The study concluded on the efficiency of the real options framework. Akakandelwa (2014) submitted that while real options models can serve as a veritable tool to verify whether a project has sufficient residual value to cater for land acquisition, not all projects have an option value. The study concluded on the need for investment managers to embrace the adoption of ROA.

From the foregoing, it is apparent that most of the studies favoured the adoption of real options techniques over the traditional approaches. However, given that the application and findings of these studies are predominantly situated in developed economies, and do not provide sufficient empirical analysis especially from the perspective of an emerging RED market, the findings from these studies may not be congruent with evidence from emergent economies like Nigeria; with a different market and peculiar economic climate. Apparently, differing market and economic characteristics might introduce some variations into the application of real options into RED when examined in the context of the local market wherein the RED situates.

3.0 Data and Method

Secondary data was employed for the study was sourced from two estate surveying and valuation (ESV) firms practicing in Lagos, Nigeria. The data included in-house data on recently completed commercial properties. Thus, while most firms were not willing to release the specific data for property developments, the two ESV firms werefavourably disposed to provide the data needed for the study; however, under the condition of anonymity. Information on specific building project included details such as construction cost, construction period, cost of land, vacancy rate and property yield among others. Hence, the study analysed the construction and other market details of three case studies labelled as C_1, C_2 and C_3 where "C" denotes commercial property.

The case study C_1 is a Grade A office property located in Victoria Island, Lagos. It is a high rise office complex of six (6) floors with a gross and net floor areas of $2{,}100m^2$ and $1{,}600m^2$ respectively. The project commenced in the year 2013 and was completed in the year 2016. The case study C_2 is a Grade B office property located in Ikeja, Lagos. It is a high rise office property of seven (7) floors. The property has a gross floor area of 2,950m^2 and a net floor area of 2,407.4m^2. The project was commenced in the year 2013 and completed in 2015. The case study C_3 is Grade C commercial office complex located in Ikeja, Lagos. It is a low rise office property with four (4) floors with a gross and net floor areas of 805m^{2}and 577.7m^2 respectively. The project was commenced in the year 2014 and completed in the year 2015. Further details regarding the case studies are presented in Table 1

For each of the case studies, first, the appraisal was done under the notion of pre-investment analysis, assuming that the developments have not been executed. Thus, the parameters were assumed based on an initial development outlay. The appraisal of the projects was done to determine the viability of the investment based on the most optimistic occupancy rate and at the prevailing rental value/m^2. Thus, under the pre-investment assumption, three scenarios were analysed, these are the most optimistic scenario (best case scenario); where occupancy rates and rental values are at optimal levels. The second is the most likely scenario (middle case scenario); where the occupancy rate decreases while rental value remains at an optimal level. The third scenario analysed the effect of both a downward trend in the expected occupancy rate and the rental values (most pessimistic scenario; worst case scenario). Thus, a method somewhat akin to a sensitivity/scenario analysis was employed to re-evaluate the project cash flow under different scenarios and determine their likely appraisal outcomes based on the changing conditions and assumptions.

Table 1. Construction and Property Details for Commercial Developments - C_1, C_2 and C_3

Project Details	Project C_1	Project C_2	Project C_3
Location of the project(s)	Victoria Island, Lagos	Ikeja, Lagos	Ikeja, Lagos
Total number of floors	*6*	*7*	*4*
Size of land/site area in m^2	*1100*	*1300*	*950*
Cost of Land (as at project commencement)	*350,000,000.00*	*150,000,000.00*	*80,000,000.00*
Cost of Land (now; after project completion)	350,000,000.00	*240,000,000.00*	*100,000,000.00*
Rental value/m^2 of the property	*100,000.00*	*45,000.00*	*25,000.00*
Cash outflow (outgoings) in percentage	*20%*	*12%*	*10%*
Occupancy rate (in percentage)	*100%*	*90%*	*100%*
Operating expense (service charge) in percentage	*20%*	*30%*	*25%*
Date/Year of commencement of project	*2013*	*2013*	*2014*
Date/Year of completion of project	*2016*	*2015*	*2015*
Total Gross floor area (in m^2)	*2100*	*2950*	*805*
Net floor area	*1600*	*2407.4*	*577.7*
Total project sum/construction costs (less land cost)	*550,000,000.00*	*850,000,000.00*	*180,000,000.00*
Estimated current value of the development	*2,500,000,000.00*	*1,700,000,000.00*	*350,000,000.00*

Furthermore, given that the projects have been constructed and they are in the operational phase, the study appraised each of the case studies for vertical expansion, assuming that the projects have been phased, with an intention to vertically expand at a later period. The appraisal was based on current market occupancy rates, volatilities and other economic indicators. The appraisal for vertical expansion was also done under the three different scenarios as identified earlier, these are the most optimistic, the most likely and the most pessimistic scenarios.

The appraisal analysis of the projects was examined using the NPV, payback period and IRR traditional appraisal techniques. Where the NPV is positive, that is, greater than zero (0), the investment is adjudged viable. However, with respect to the payback period, the benchmark period of 25 years was adopted to determine the viability. This owes to the fact that most long-term loans have an average of 15 to 25 years as payback period. Thus, investment outlays with payback exceeding 25 years were regarded as not being viable. The IRR for each project was compared against the market average to determine the viability. The investment is deemed viable where the rate of return is higher than the market average.

Having determined the appraisal outcomes based on the traditional models, the study examined the effect of two types of option. These are the option to delay investment and the option of phasing (vertical expansion) of the project. In evaluating the options to delay and vertical expansion under the real options model, the Samuelson McKean formula was employed. There are other methods such as the Binomial method, Monte Carlo Simulation method, the Black-Scholes and the stochastic differential equations. However, authors (such as Cailao, 2009; Masunaga, 2007; Akankedelwa, 2014) have noted some criticisms with the use of some other methods in apprising RED. Thus, the binomial method was not adopted given the fact that it best applies to an investment with a finite lifespan. Given that RED could be held in perpetuity/infinitely, this method was not considered. Also, the Black-Scholes model was developed primarily for valuing financial assets, its application will not be suitable for real estate assets. In addition, the Monte Carlo Simulation method was not employed given that it assumes a single risk-adjusted discount rate, this might lead to either an overestimation or underestimation of the real option value, except when employed under the risk-neutral dynamics. However, this makes the model more complicated and confusing. The stochastic differential equation was also not considered given the complications and the high possibility of wrong estimations coupled with the fact that the approach only provides an approximate solution. Thus, the real options method employed for the study was the Samuelson McKean Formula given that the method has broad applicability.

The data need for the Samuelson McKean model include the volatility (standard deviation, s.d) of the total returns on such comparable commercial real estate properties. To obtain the volatility values, aggregated data on the capital and rental values of comparable commercial properties was sourced from ESV firms operating in the study area for a period of thirteen (13) years (2004 - 2016). The capital and rental values were subsequently collated to determine the total return.

However, due to the problem of underestimation of risk, which is peculiar to appraisal based return series in the real estate industry; the capital return component was de-smoothened. Learning from previous studies (see for instance, Geltner, 1993; Brown and Matysak, 2000; Hoesli, Lekander, and Witkiewitc, 2004; Lizieri, 2013), the de-smoothening was done employing first-order serial autoregressive correlation and lagged-off by 1, using the model in equation 1:

$$R_{mt} = \frac{r_t - \propto r_{t-1}}{1 - \propto} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: R_{mt} = return observable if market prices were correctly captured by valuation

r_t = return derived from the valuation series

α = a constant lying in the range from 0 to 1

r_{t-1} = return derived from the valuation series of previous period.

The resulting de-smoothened capital return component was computed with the actual income return to arrive at the de-smoothened total return for each year. The standard deviation of the desmoothed returns was subsequently imputed into the real options model.

Other inputs required for the Samuelson McKean formula include the yield on the property and the risk-free (r_f) rate. While the yield on the property was sourced from ESV firms in the Lagos property market, the risk-free rate (r_f) was sourced from the Central Bank of Nigeria statistical bulletin. Other data need include the underlying market value of the property and the construction cost. The underlying market value of the property and the construction cost were obtained from the ESV firms who constructed the properties used as case study. The expected risk premium of the underlying market is usually not beyond 2%, thus the study adopted a 2% risk premium.

The Samuelson McKean model was used to appraise the investment using three functions, the option elasticity, hurdle price and real option value.

Option Elasticity, η, this represents the percentage change in value on the unexercised option in response to a unit change in the value of the asset. Mathematically, the option elasticity (equation 2) is expressed as:

$$\eta = \frac{y_v - r_f + \frac{\sigma_v^2}{2} + \left[\left(r_f - y_v - \frac{\sigma_v^2}{2}\right)^2 + 2r_f\sigma_v^2\right]^{1/2}}{\sigma_v^2} \ldots\ldots (2)$$

Hurdle price, *S**, (equation 3), this represents the minimum value of the underlying investment that "triggers" exercising the real option.

$$S^* = \frac{K_0 \eta}{\eta - 1} \ldots\ldots\ldots\ldots\ldots (3)$$

Real option value, R_0, (equation 4), this represents the opportunity cost of holding the development in its current state.

$$Real\ Option\ Value = R_0 = (S^* - K_0)\left(\frac{S}{S^*}\right)^{\eta} \ldots\ldots\ldots (4)$$

Where:

K_o = development cost, that is, the present value of all total expected capital expenditures on the investment

r_f= the risk-free interest rate proxied by the 90-day T-bill rate

y_v = property initial yield

S = current value of the underlying asset estimated by the discounted cash flows or market value of comparable properties

σ_v = volatility of property price estimated by the standard deviation of asset's rate of return

Based on these input parameters, the Samuelson McKean Model is used to determine if it was viable to have gone ahead with the initial development and phasing of the project or otherwise. Where the critical value of the underlying asset (S*) is lower than the underlying asset's current market value (S), the investment decision is positive, thus the investment can proceed. If otherwise, the investor is advised to wait for a favourable market timing when the market uncertainty is cleared or consider alternative options.

With respect to comparing the appraisal outputs of the traditional models and the ROA, while it is expected that the investment decisions based on the outputs of the traditional appraisal models might be conflicting, the output of the DCF (NPV) was used as a basis for the investment decision. The choice of the DCF (NPV) appraisal result owes to the arguments of Walters and Giles (2000) and Brealey *et al* (2012) that the NPV is most frequently adopted of the traditional appraisal models. The comparison was done with a view towards ascertaining if the decisions of the traditional appraisal outcomes were worthwhile decisions that would have maximized investors returns based on prevailing market parameters, as against the decision based on the ROA.

4.0 Findings and Discussion of Results

The findings and discussions were done in two parts. First, for the traditional approach and the ROA under the pre-development framework; and second for the traditional approach and the ROA under the assumption of vertical expansion.

Assumptions:

i. The capitalization rate adopted was based on evidences form local ESV firms for a comparable property in the identified locations
ii. The rental growth rate was calculated based on the implicit growth rate formula
iii. The rent review period is set at two years. This conforms to the practice of the local ESV firms
iv. The inflow is given as the rental value less 20% allowance for outgoings. The value obtained for year one was subsequently adjusted for growth for subsequent years
v. The review was done up to the 30th year after which the net rent was capitalized in perpetuity
vi. Initial Cost is the sum total of the land and construction costs
vii. The allowance of 20% for outgoings is based on the projections of the property developers

4.1 Pre-development Analysis

4.1.1 Traditional Appraisal Analysis

For case study C_1, the development commenced in 2013. However, the appraisal analysis was calculated based on the market details as at 2012, assuming that the developers had to make decisions regarding project investment by 2013.

The 90-day T-bill rate at 2012 was 11.77%

e (equated yield) = T-bill rate + 2% premium = 13.77%

k (capitalization rate) = 0.05 (5%)

g (growth rate) = 0.1875%

t (rent review) = 2 years

While the prevailing market rent based on estimates from local agents for similar "Grade A" high rise office property was about ₦100,000/m^2 and allowance for outgoing at 20%/m^2.

Based on market trends, the occupancy rate for similar office properties in the Lagos Island market is about 70%, However, the investor is optimistic for 100% occupancy. The DCF(NPV) analysis for the project under the most optimistic scenario (best case) is ₦1,660,000,000.00, with a payback period of 12 years. The IRR for the project is 16.28% which is higher than the market average rate of return for comparable commercial properties in the location which is 5.00%.

NPV Analysis for C_1 under the Most Optimistic Scenario (100% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{128{,}000{,}000}{(1 + 13.77\%)^n} - 900{,}000{,}000$$

= ₦1,660,000,000

However, where the target occupancy rate of 100% cannot be achieved, based on the 30% prevailing vacancy rate in the market, a further analysis was done to determine the sensitivity of the appraisal outputs to: (i) a 70% occupancy rate *(most likely scenario)* and (ii) a 70% occupancy rate and a 25% decrease in rent/m^2 *(most pessimistic scenario).*

NPV Analysis for C_1 under the Most Likely Scenario (70% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{89600000}{(1 + 13.77\%)^n} - 900000000$$

= ₦892,000,000

NPV Analysis for C_1 under the Most Pessimistic Scenario (70% occupancy rate and 25% decrease in rent/m^2)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{67200000}{(1 + 13.77\%)^n} - 900000000$$

= ₦444,000,000

The NPV output for C_1 under the most likely scenario (middle case) is ₦892,000,000. This shows a 46.27% decrease in the projected NPV when compared with the 100% occupancy rate. Also, the NPV outcome for the most pessimistic scenario, ₦444,000,000, shows a 73.25% decrease when compared with the initial NPV of ₦1,660,000,000 at 100% occupancy and ₦100,000/sqm. An examination of the payback period shows that under the most likely scenario, project C_1 had a payback period of 18 years. However, based on a benchmark of 25 years, the project would not be able to pay back until the 26th year under the most pessimistic scenario. The IRR for the middle case and worst case is 9.31% and 4.93% respectively. This represents a 42.81% and 69.72% decrease in the rate of return.

The foregoing suggests that where the investor's target rental value and/or occupancy rate cannot be achieved, the investor might not be able to payback under the worst case scenario, there is also a potential for loss as high as 73.25% when compared with the projected NPV outcomes of the best case scenario and a decrease as high as 68.7% in the rate of return. The project also could not achieve the expected payback period of 25 years under the worst case scenario. However, where the investment decision is premised on the NPV results, it might be advised that the project commences given that under the three (3) scenarios examined the NPV was positive. Thus, the investor might still be expected to proceed with the development, though with some form of caution; given the market uncertainties.

For case study C_2, the project's appraisal was calculated based on market data for year 2012. The following parameters were used for analysis:

The 90 days T-bill rate as at 2012 is given as 11.77%

equated yield = 11.77% + 2% premium = 13.77%

k = 0.055 (5.5%)

g (growth rate) = 0.1768

Rent review at every two years.

Allowance for outgoing is at 20%/m^2.

Market trends in the Lagos Mainland property market show that similar Grade B properties have a vacancy rate of about 25%. However, the investor is optimistic about higher occupancy rate of 100%. The following is the appraisal analysis for the best case scenario.

The analysis showed that the investment had an NPV of ₦575,490,905 if the project is able to achieve 100% occupancy at the 45,000/m^2 rental value, with a payback period of 22 years and an IRR of 6.04% which is above the market average of 5.5%.

NPV Analysis for C_2 under the Most Optimistic Scenario (100% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{86652000}{(1 + 13.77\%)^n} - 1000000000$$

= ₦575,490,905

A sensitivity analysis of the project was examined to determine the margin of the variation in the expected profit. This was done assuming: (i) a 75% occupancy rate (*most likely scenario) and* (ii) a 75% occupancy rate and a 25% decrease in rent/m^2 *(most pessimistic scenario)*

NPV Analysis for C_2 under the Most Likely Scenario (75% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{64989000}{(1 + 13.77\%)^n} - 1000000000$$

= ₦181,618,179

NPV Analysis for C_2 under the Most Pessimistic Scenario (75% occupancy rate and 25% decrease in rent/m^2)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{48741750}{(1+13.77\%)^n} - 1000000000$$

= -₦113,786,366

The results of the NPV analysis under the two scenarios were ₦181,618,179 and -₦113,786,366 respectively. This signifies a 68.44% and 119.77% decrease respectively when compared with the NPV output of the best case scenario. An examination of the payback period and IRR shows that under the two scenarios, the project will not be able to achieve a 25 years payback period, and the IRR values are 2.03% to -1.36% respectively.

With respect to the NPV outputs, the implication of the foregoing analysis is that where the market experiences a downturn after the project has been initiated and rental value and/or occupancy rate cannot be achieved, there is a likelihood of about 119.77% loss.

The project analysis for C_3 was based on details available as of the year 2013. For the analysis of the project outlay, the input parameters for the analysis are stated as follows:

The 90 days T-bill rate at 2013 is given as 10.97

equated yield = 10.97% +2% premium = 12.97%

k = 0.04 = 4%

g (growth rate) = 0.1910

rent review at every two years

Allowance for outgoings is at 20%/m^2

The prevailing trend in the Lagos Mainland property market indicates that similar Grade C office properties have vacancy rates of about 20%. However, there is a high level of optimism by the investor of achieving a 100% occupancy rate; being a recently completed office property. The NPV analysis (most optimistic scenario) revealed an NPV of ₦8,353,893.

NPV Analysis for C_3 under the Most Optimistic Scenario (100% occupancy rate)

NPV $\quad = PV^* - \text{Initial Cost}$

$$= \sum_{n=1}^{\infty} \frac{11554000}{(1+13.77\%)^n} - 260000000$$

= ₦8,353,893

The analysis further examined the sensitivity of the NPV outputs to an 80% occupancy rate and both an 80% occupancy rate and a 25% reduction in rental value/m^2.

NPV Analysis for C_3 under the Most Likely Scenario (80% occupancy rate)

NPV $\quad = PV^* - \text{Initial Cost}$

$$= \sum_{n=1}^{\infty} \frac{9243200}{(1+13.77\%)^n} - 260000000$$

= -₦45,316,886

The NPV analysis of the investment at 20% vacancy rate, gave an NPV output of -₦45,316,886. This indicates a 642.46% loss when compared with the NPV output of the most optimistic scenario. Given that the NPV of the most likely scenario was negative, it is expected that the worst case scenario; will give a negative NPV outcome. A brief analysis of the NPV (worst case scenario) revealed an outcome of -₦98,987,664. This represents a -1,284.93% decrease in the expected NPV of the best case scenario. An examination of the project's payback period and IRR showed that the payback period exceeded the 25 years benchmark for the three scenarios, with a rate of return of 0.33%, -1.92% and -4.56% for the best case, middle case and worst case scenario respectively.

The foregoing indicates that where the target occupancy rate and/or rental value/m^2 could not be achieved at the projected cost outlay, there is a likelihood of the investment having negative NPV values, resulting into a -1,284.93% loss. This presupposes that it might be expected that the investor needs to exercise some caution before going ahead with the development. This is further exacerbated by the inability to achieve a payback of 25 years and the rate of return is far lower than the market average of 4.00%.

A summary of the traditional appraisal output is presented in Table 3.

Table 3 Summary of Traditional Appraisal Outputs

Case Study	Appraisal Model	Most Optimistic Scenario	Most Likely Scenario	Most Pessimistic Scenario
	NPV	₦1,660,000,000.00k	₦892,000,000.00k	₦444,000,000.00k
C_1	IRR	16.28%	9.31%	4.93%
	PbP	12 years	18 years	after 25 years
	NPV	₦575,490,905.00k	₦181,618,179.00k	- ₦113,786,366.00k
C_2	IRR	6.04%	2.03%	-1.36%
	PbP	22 years	after 25 years	after 25 years
	NPV	₦8,353,893.00k	- ₦45,316,886.00k	- ₦98,987,664.00k
C_3	IRR	0.33%	-1.92%	-4.56%
	PbP	after 25 years	after 25 years	after 25 years

PbP – payback period

4.1.2 Real Options Analysis (Samuelson McKean's Model)

Having examined the results of the traditional appraisal outputs for C_1, C_2 and C_3, the analysis of the real option value for the case studies was analysed using the Samuelson McKean model.

The Samuelsson McKean model assumes that options can be exercised at any time in the future (perpetual option). However, the exercise of such options is only deemed viable where the critical value underlying the asset, that is, the hurdle price, S*, is lower than the underlying asset's current market value, S. Given that for a rational investor, until the asset's market value (S) exceeds the development cost, K, the project has no payoff. Thus, development is likely to be initiated at any instance where S exceeds K. However, S*, the hurdle price is the target asset value that is required to equate the project payoff to the opportunity cost of having the land undeveloped.

Thus, for the case studies, the study is introducing a perpetual option pricing model to value the option to delay/commence the project. The result as presented in Table 4 showed that for C_1, the critical value, S*, underlying the asset (₦1,658,931,796) was below the underlying current market value, S, of the asset (₦2,500,000,000). Hence, given that the hurdle price is lower than the asset's current market value, the decision to go ahead with the development is a viable option for the investor. The decision to commence the project C_1 has an option value of ₦2,048,116,991. However, for case studies C_2 and C_3, the critical values underlying the assets, S*, ₦2,385,817,557; and ₦588,851,613 respectively were lower than the underlying assets current market value, S, ₦1,700,000,000 and ₦350,000,000 respectively. Thus, the decision will be to delay the initiation of the developments under the prevailing economic conditions till there is a favourable market and uncertainties about input parameters are cleared. This owes to the lower hurdle price of the case studies C_2 and C_3. While C_2 had an option value of ₦907,172,298, C_3 had option value of ₦193,266,714.

The foregoing presupposes that developments of C_2 and C_3 currently yields lower market prices (S) than the hurdle prices (S*). Hence, for the case studies (C_2 and $C_{3)}$, the option to delay might be considered more reasonable so that more information can be gathered with the passage of time and uncertainties can be cleared about the intended project and the market conditions improve positively to favour project commencement. However, for case study C_1, the proposed development has a higher current market value than the hurdle price, thus, there is no need for the project to be delayed.

Table 4. Samuelson-McKean Model for Analysing Delay of Developments C_1, C_2 and C_3

Samuelson-McKean Formula: to determine option to delay/defer project commencement	CASE STUDY DEVELOPMENTS		
	C_1	C_2	C_3
Input Values:			
Underlying asset (built property) volatility (σ_v)	21.04%	21.73%	17.14%
Underlying asset (built property) current yield (y_v)	5.00%	5.50%	4.00%
Risk free interest rate (r_f)	11.77%	11.77%	10.97%
Underlying asset (built property) current mkt value (S)	₦2,500,000,000	₦1,700,000,000	₦350,000,000
Construction cost exclusive of land (K_o)	₦550,000,000	₦850,000,000	₦180,000,000
Expected return risk premium in underlying asset (RP(S))	2.00%	2.00%	2.00%
Output values:			
Option (land value) elasticity (" η " *(dLAND/dS) / (LAND/S)*)	1.50	1.55	1.44
Hurdle Benefit/Cost Ratio (S^*/K_o)	3.02	2.81	3.27
Optimal Land Value Fraction at Development ($(S^*-K_o)/S^*$)	67%	64%	69%
Critical Value of Underlying Asset (optimal development at not below, Hurdle Price S*):	₦1,658,931,796	₦2,385,817,559	₦588,851,613
Optimal immediate exercise (development)?:	Yes	No	No
Real Option Value (R_o)	₦2,048,116,991	₦907,172,298	₦193,266,714
Current Land Value Fraction (LAND/S)	81.92%	53.36%	55.22%
Expected return risk premium in land investment (RP)	2.99%	3.11%	2.88%
Opportunity Cost of Capital (OCC) for Land Investment	14.76%	14.88%	13.85%

In summary (Table 5), while examining the option to delay investment, for C_1, based on the three scenarios of the best case (most optimistic), worst case (most pessimistic) and middle case (most likely), the NPV outputs gave positive NPV outcomes, implying that the project is viable. This was also corroborated by the real options analysis, which gave a positive decision to commence the development. For case study C_2, while two of three scenarios (best case and middle case) had positive NPV, the worst case scenario (most pessimistic) had a negative NPV outcome, implying that the project is only viable where the occupancy and rental value/m^2 does not fall below the market average. However, the real options analysis showed that the investment should not commence, given that critical value is lower than the current market value of the built property. For C_3, a similar trend was observed, only the best case scenario had a positive NPV, while the middle case and worst case had negative NPV outcomes. The real options analysis also would not suggest going ahead with the investment outlay given the prevailing economic and market parameters. Hence the need to defer project commitments.

Table 5: Summary of Appraisal Decision of the Case Studies (NPV and ROA)

	NPV Appraisal Output			**Samuelsson McKean**
Case Study	**Most Optimistic Scenario**	**Most Likely Scenario**	**Most Pessimistic Scenario**	**Decision**
C_1	Project commencement is viable	Project commencement is viable	Project commencement is viable	Initiate commence of development
C_2	Project commencement is viable	Project commencement is viable	Project commencement is not viable	Delay commencement of development
C_3	Project commencement is viable	Project commencement is not viable	Project commencement is not viable	Delay commencement of development

4.2 Vertical Expansion Appraisal (Phasing of Project)

The study also examined the appraisal outputs of the case studies by appraising the viability of the projects for a vertical expansion (phasing of the project). This was done using the traditional models and the ROA. The decision for vertical expansion was considered for the year 2017, hence, the data input for the appraisal models was based on data from the local markets as at 2016. As in the previous analysis, for each of the case studies, three scenarios of most optimistic (best case), most pessimistic (worst case) and most likely (middle case) were also analyzed for each case study.

The cash flow was calculated to include the extra cost of vertical expansion. In determining the cost of the vertical expansion for each case study, the construction cost per square meter was determined and used as a basis to estimate the cost of two extra floors to be added for the vertical expansion. Also, an extra 30% cost was added to the cost/m^2 for the construction of the two extra floors. The addition of the extra 30% was to serve as contingency cost of development. However, the option of vertical expansion was based on the assumption that each of the construction (case study) had taken into account the future anticipation for a vertical expansion, that is, phasing of the project. Hence, it is expected that the foundation and other structural details have been accounted for at the initial design and construction stage. Furthermore, it was assumed that town planning laws and other legal/ building regulatory restrictions have been held constant. Thus, the development is assumed considered within the zoning approval for the areas wherein the case studies are situated.

In analysing the cost of the vertical expansion for case study $C_{1,}$ the cost of the additional two floors was calculated as follows:

$$\textbf{Construction}\,\frac{\textbf{cost}}{\textbf{m}^2} = \frac{\textbf{Total construction cost}}{\textbf{Gross floor area}}$$

$$\textbf{Construction}\,\frac{\textbf{cost}}{\textbf{m}^2} = \ \ \mathbf{550{,}000,\frac{000}{2100}}$$

= **₦261,904.76**

Given that the property C_1 has six floors, to determine the floor area for each floor

$$= \frac{\textbf{Gross floor area}}{\textbf{number of floors}} = \frac{\mathbf{2100}}{\mathbf{6}} = \mathbf{350}m^2$$

Hence, construction cost for a floor	= ₦261,904.76 X 350m^2
	= ₦91,666,666.67
Construction cost for the two floors	= ₦91,666,666.67 X 2
	= ₦183,333,333
+ 30% contingency$^{(assumed)}$	= <u>₦55000000</u>
Construction cost for two floors	= **₦238,333,333.00k**

The current ratio of gross floor area (GFA) to net floor area (NFA) for C_1 = 1.3125

The new net floor area after the vertical expansion was calculated as follows:

New gross floor area = 2100 + 700 = **2800m^2**

New net floor area = 2800/1.3125 = **2133.33m^2**

New construction cost (for vertical expansion)

= previous cost of construction (excluding land cost) + cost of vertical expansion

= 550,000,000 + 238,333,333

New construction cost (for vertical expansion) = **₦788,333,333.00k**

The same method of analysis was applied to other case studies C_2 and C_3 in determining the construction cost of the vertical expansion. Presented in Table 6 are the values of the input parameters for each case study.

Table 6. Inputs Parameters for the Vertical Expansion of C_1, C_2 and C_3

Input Parameters	C_1	C_2	C_3
Construction cost/m^2	₦261,904.76	₦288,135	₦223,602
Gross floor area	2100	2950	805
Cost of vertical expansion plus 30% contingency	₦238,333,333.00k	₦315,714,606.70k	₦117,000,000.00k
New gross floor area	2800	3792.86	1207.5
New Net floor area	2133.33	3095.23	866.50
New construction cost	₦788,333,333.00k	1,165,714,606.00k	297,000,000.00k

4.2.1 Traditional Appraisal Analysis

The result of the NPV analysis for C_1 showed that based on the most optimistic scenario, the project is viable with an NPV of ₦1,766,805,770, a payback period of 16 years and a rate of return of 9.92%.

NPV Analysis for C_1 under the Most Optimistic Scenario (100% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{170666400}{(1 + 13.77\%)^n} - 1712774485$$

= ₦1,766,805,770

Analysis of the most likely and most pessimistic scenarios showed that the NPV output is ₦827,159,682 and ₦279,032,797 respectively. This represents a decrease of 53.18% and 84.21% decrease in the profitability when compared with the output of the best case scenario. Furthermore, the project's payback period exceeded the 25 years benchmark under the two scenarios and the IRR was 5.19% and 1.92% respectively for the most likely and most pessimistic scenarios.

NPV Analysis for C_1 under the Most Likely Scenario (70% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{119466480}{(1 + 13.77\%)^n} - 1712774485$$

= ₦827,159,682

NPV Analysis for C_1 under the Most Pessimistic Scenario (70% occupancy and 25% decrease in rent/m^2)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{89599860}{(1 + 13.77\%)^n} - 1712774485$$

= ₦279,032,797

Given that the investment decision is premised on the NPV results, the decision to expand vertically had positive NPV outputs under the three different scenarios of most optimistic, most likely and most pessimistic, though with a reduction in NPV as high as 84.21%. It however suggests that under the market conditions, the investment would be expected to remain viable.

An examination of the case study, C_2, revealed that for the most optimistic and most likely scenarios, the NPV outputs are ₦160,100,608 and -₦359,805,574 respectively.

NPV Analysis for C_2 under the Most Optimistic Scenario (100% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{122562000}{(1 + 13.77\%)^n} - 2152869718$$

= ₦160,100,608

NPV Analysis for C_2 under the Most Likely Scenario (75% occupancy)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{91928286}{(1 + 13.77\%)^n} - 2152869718$$

= -₦359,805,574

The result showed that though the best case scenario had a positive NPV, the most likely scenario recorded a negative NPV output with a percentage decrease of 324.74%. Given that the middle case had a negative NPV output, the worst case scenario will apparently turn out a negative output. A brief analysis of the worst case scenario (most pessimistic) revealed an NPV output of -₦749,850,371 representing a 568.36% decrease. With respect to the payback period for all the three scenarios, the payback period exceeded the 25 years benchmark. Also, the project's IRR under the three scenarios are 0.84%, -2.06% and -4.68% respectively. These are apparently below the market average of 5.5% for comparable commercial properties.

This implies that the decision to vertically expand C_2, which currently has a 90% occupancy rate might not be a viable investment option based on the NPV outcomes. The findings suggest that under an optimistic market, the investor's return appears to be secured. Where the market indices nosedives, the return on investment might not be guaranteed. This apparently exposes the investor to the risk of a downside loss.

The analysis of the NPV outputs for C_3, based on the most optimistic scenario, revealed an NPV of -₦171,969,706. The negative NPV output shows that the investor should not embark on a vertical expansion given the potential for significant losses, even though the property currently enjoys a 100% occupancy rate. It also presupposes that the middle and worst case scenarios would lead to negative NPVoutputs. However, a brief examination of the middle and worst case scenarios revealed NPV outputs of -₦256,015,759 and –₦340,060,842 respectively. A cursory analysis of the payback period and IRR for the project under the three scenarios showed that while the project would not payback within the 25 years period, the rate of return was -3.14%, -5.01% and -7.28% respectively for the three scenarios.

NPV Analysis for C_3 under the Most Optimistic Scenario (100% occupancy rate)

NPV = PV* - Initial Cost

$$= \sum_{n=1}^{\infty} \frac{19496295}{(1+13.77\%)^n} - 627477045$$

= -₦171,969,706

A summary of the traditional appraisal outputs is presented in Table 7.

Table 7 Summary of Traditional Appraisal Outputs (Vertical Expansion)

Case Study	Appraisal Model	Most Optimistic Scenario	Most Likely Scenario	Most Pessimistic Scenario
C_1	NPV	₦1,766,805,770.00k	₦827,159,682.00k	₦279,032,797.00k
	IRR	9.92%	5.19%	1.92%
	PbP	16 years	after 25 years	after 25 years
C_2	NPV	₦160,100,608.00k	-₦359,805,574.00k	-₦749,850,371.00k
	IRR	0.84%	-2.06%	-4.68%
	PbP	after 25 years	after 25 years	after 25 years
C_3	NPV	- ₦171,969,706.00k	-₦256,015,759.00k	-₦340,060,842.00k
	IRR	-3.14%	-5.01%	-7.28%
	PbP	after 25 years	after 25 years	after 25 years

PbP – payback period

4.2.2 Real Options Analysis (Samuelson McKean's Model)

Having examined the results of the traditional appraisal outputs for each of the case studies under the three different scenarios, the real options analysis based on Samuelson McKean formula was also examined. The result of the case studies; C_1, C_2 and C_3 are presented in Table 8.

Table 8 Samuelson-McKean Model for Analysing Vertical Expansion of C_1, C_2 and C_3

Samuelson-McKean Formula: to determine option for vertical expansion	C_1	C_2	C_3
Input Values:			
Underlying asset (built property) volatility (σ_v)	25.15%	22.46%	22.46%
Underlying asset (built property) current yield (y_v)	5.00%	5.50%	4.00%
Risk free interest rate (r_f)	13.96%	13.96%	13.96%
Underlying asset (built property) current mkt value (S)	₦3,400,000,000	₦2,228,562,291	₦487,406,250
Construction cost exclusive of land (K_o)	₦788,333,333	₦1,165,714,606	₦297,000,000
Expected return risk premium in underlying asset (RP(S))	2.00%	2.00%	2.00%
Output values:			
Option (land value) elasticity (" η" *(dLAND/dS) / (LAND/S)*)	1.38	1.45	1.30
Hurdle Benefit/Cost Ratio (S^*/K_o)	3.66	3.20	4.31
Optimal Land Value Fraction at Development ($(S^*-K_o)/S^*$)	73%	69%	77%
Critical Value of Underlying Asset (optimal development at not below, Hurdle Price S*):	₦2,886,973,833	₦3,735,851,751	₦1,280,369,762
Optimal immediate exercise (development)?:	Yes	No	No
Real Option Value (R_o)	₦2,611,666,667	₦1,212,909,055	₦279,634,548
Current Land Value Fraction (LAND/S)	76.81%	54.43%	57.37%
Expected return risk premium in la investment (RP)	2.75%	2.91%	2.60%
Opportunity Cost of Capital (OCC) for Land Investment	16.71%	16.87%	16.56%

The result showed that the decision to vertically expand the project would not be considered viable under the present market and project conditions for the case studies C_2 and C_3. This owes to fact that the critical value of the underlying assets (S*) is higher than the underlying assets current market value

(S). While the critical values for C_2 and C_3 are ₦3,735,851,751 and ₦1,280,369,762 respectively, the current market values are ₦2,228,562,291 and ₦487,406,250respectively. For each of these case studies, it will be a worthwhile decision to wait, understudy the market and clear the uncertainty about project inputs before embarking on the decision to vertically expand the projects despite the fact that the case studies have occupancy rates above the market average.

However, for case study C_1, the decision to embark on the vertical expansion is considered viable as the critical value of the underlying asset, S* (₦2,886,973,833) was lower than the underlying asset's current market value (S) ₦3,400,000,000.

The summary in Table 9 showed that vertically expanding investment C_1 is viable under any of the three scenarios given that the NPV outputs are positive. This was also corroborated by the real options analysis, which showed a positive decision to vertically expand the development. For case study C_2, only one of the three scenarios, best case, had positive NPV, the most likely and worst case scenarios had negative NPV outcomes. This implies that the decision to vertically expand will only be viable where the occupancy and rental value/m^2 is at optimal levels, this assumption might often be far from reality. From the perspective of the real options analysis, the investment should not be vertically expanded given that critical value is lower than the current market value of the built property. For C_3, the NPV outcomes showed that vertical expansion will not be a viable option as all the NPV outcomes recorded a negative value. The real options analysis also would not suggest going ahead with the vertical expansion of the investment outlay given the prevailing economic and market parameters.

Table 9. Summary of Appraisal Decision of the Case Studies (NPV and ROA)

	NPV Appraisal Outputs			Samuelsson McKean
Case Study	**Most Optimistic Scenario**	**Most Likely Scenario**	**Most Pessimistic Scenario**	**Decision**
C_1	Vertical expansion is viable	Vertical expansion is viable	Vertical expansion is viable	Commence expansion
C_2	Vertical expansion is viable	Vertical expansion is not viable	Vertical expansion is not viable	Delay vertical expansion
C_3	Vertical expansion is not viable	Vertical expansion is not viable	Vertical expansion is not viable	Delay vertical expansion

5.0 Conclusion

The study examined the adoption of ROA in the appraisal property investments. This was with a view towards enhancing real estate investment appraisal and decision making. The study analysed the appraisal decisions based on the results of the traditional technique; DFC(NPV), in comparison with the outputs and decisions of the ROA using the Samuelson McKean model. The results showed that while the traditional model appears to be a viable appraisal tool in an optimistic market; with positive market trends and forecasts. It however might not be an optimal choice for RED appraisals in volatile markets. This apparently becomes more obvious where the market and other economic inputs tend to fluctuate significantly, thereby increasing investment uncertainty and the likelihood of a downside loss. Obviously, the probability of worse-case investment scenarios may not be highly anticipated by most optimistic investors, hence the need to be cautious when employing the traditional models, especially in emerging markets with attributable high volatilities and uncertainties.

Furthermore, the results suggest that while the NPV model, may sometimes give a well-informed appraisal decision when incorporated with some form of sensitivity analysis, the ROA could be regarded as a complementary appraisal tool that could help the appraiser decide on the viability of an investment outlay based on observable market trends and a forecast of market projections based on all likely scenarios ranging between the worst case and best case scenarios. The ROA employs a robust analysis of both extremes of market optimism and pessimism and guides the investment decision appropriately. It thus suggests that RED can be appraised more accurately through a combination of the traditional models and the ROA model. This helps the appraiser to make a well-informed decision regarding the investments.

The implication of the foregoing is that the traditional appraisal models might not holistically account for future market fluctuations, hence leading to tendencies of wrong appraisal and investment advice; especially during unexpected market downturns. However, the combination of traditional appraisal tools and the ROA could help avoid downside risk arising from volatilities in the RED investment market. The corollary of the foregoing is that the adoption of the ROA should be encouraged by the RED firms and appraisers with the aim of mitigating losses on investment options and enhancing the potential for higher returns on investment. The options analysed through the use of ROA enhances risk management and helps in achieving the profit maximization motive of the investor based on changing economic and market environment.

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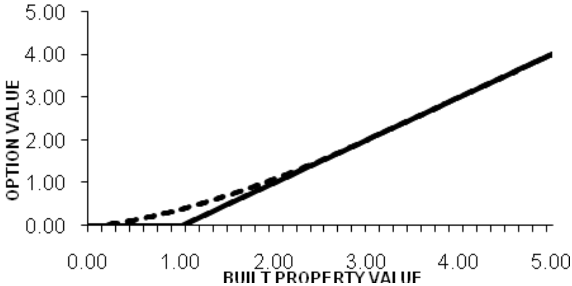
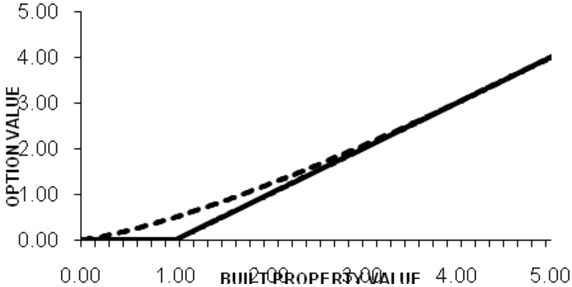
Appendix: Option Value and Payoff

Case Study C_1

Pre-investment

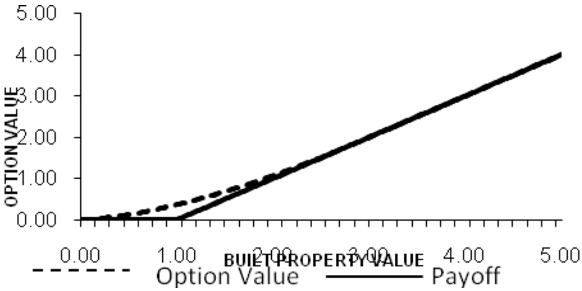


Vertical Expansion

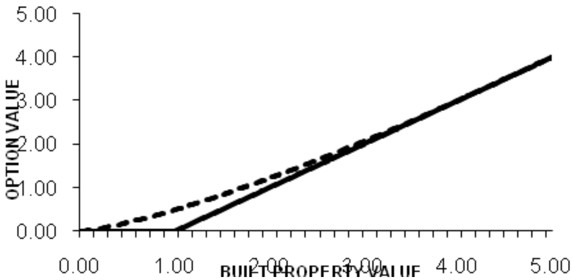


Case Study C_2

Pre-investment

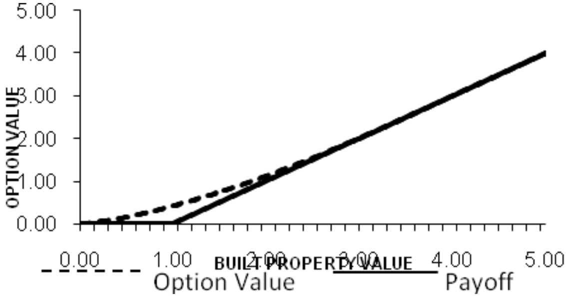


Vertical Expansion



Case Study C_3

Pre-investment



Vertical Expansion