incorporated in our example are market driven. It is important to also incorporate the probability of technical success, that is, the probability of successfully getting a drug to market. R&D clinical trial success rate probabilities can easily be incorporated into the Monte Carlo simulation.

Implementing a Real Options Approach

The real options approach just described incorporates a learning model, such that management makes better and more informed strategic decisions when some levels of uncertainty are resolved through the passage of time. It also forces management to focus on key decision points or milestones, such as when do we need to make key investment commitments? What are our options at a given point in time that allow us to take advantage of opportunities while reducing risk? What is the cost of waiting or deferring a decision?

This approach sets a premium on obtaining better information before making important decisions. It values flexibility (and identifies the cost of this flexibility) while improving decision makers' risk management capabilities. As such, it can and should be linked to project management execution because value can only be captured if the option is executed optimally.

A real options approach is straightforward to implement and is based on existing inputs and valuation methodologies already used in most companies. Real options analysis adds an additional step to the existing NPV analysis by quantifying the value of the options available to management.

CASE 8: ALTERNATIVE USES FOR A PROPOSED REAL ESTATE DEVELOPMENT—A STRATEGIC VALUE APPRAISAL

The following is contributed by Robert Fourt (contact: Gerald Eve, 7 Vere Street, London W1G OJB, UK, +44(0)2074933338, rfourt@geraldeve.com). Fourt is a partner within the Planning & Development and Structured Finance teams of UK-based real estate consultants, Gerald Eve. He specializes in development consultancy providing advice on a wide range of schemes to private, corporate, and public sector clients with a particular emphasis on strategy, finance, and project management. Gerald Eve is a multidisciplinary practice employing more than 300 people operating from a head office in central London and a regional network that spans the United Kindgom. The firm provides specialist advice in all real estate sectors.

Introduction

It is not uncommon in real estate development for an investor to hold a property where alternative land development uses may be available, subject to

planning permission (or rezoning) being obtained. A major element of the overall uncertainty often lies in securing an appropriate permission, and clearly this can convey significant value to the investor. This case example does not focus on mitigating planning uncertainty (as identified in Stage I below) but considers the option value (strategic value) that is conveyed by holding a property where marginal returns on land and profit could be earned as a result of the alternative use opportunities that could be secured.

The case study concerns two mutually exclusive alternative schemes for the same property: a retail warehouse (140,000 square feet) proposal or residential (1,206 units) development. Although the situation is a real-life example, the details have been simplified. The site is located 30 minutes east of central London (United Kingdom) in the suburb of Barking, comprises some 9 acres, and fronts a major road with an interchange giving direct access. A river runs along the eastern and southern boundaries of the property.

The basic simplified details of this case study are as follows:

- The original proposals for redevelopment envisaged the site being developed for retail, theme pub, and restaurant, which would comprise a 100,000 square foot retail warehouse with the necessary market requirement of parking, complemented by 40,000 square feet for restaurant and pub uses.
- Significant remediation works (contamination cleanup) would be necessary to be undertaken across the site together with an internal upgrading of infrastructure and the provision of a riverside walk, which would be an aspect of any redevelopment. This would likely take a year to complete prior to any development.
- Retail warehousing is an attractive investment for funds and developers alike. Building costs are relatively low and speed of construction erection is rapid; an occupier can be trading and paying rent within an 18-month period with pre-leasing construction management being straightforward with little risk for delay. Although the investment market is strong with a shortage of new stock coming into the supply chain, the occupier market is very fickle resulting in development uncertainty.

The owners of the site had concerns over the retail warehouse development as a result of the following considerations:

- The ability to secure appropriate retail occupiers for the scheme.
- The success of nearby residential schemes.
- Encouragement received from the local planning authority to consider a significant residential scheme.
- Demand for residential schemes.

It was anticipated that a residential development of some 1,206 one- and two-bedroom units (904 private and 302 social units) could be accommodated on the site. In addition a small amount of retail, restaurant, and health and fitness uses would be incorporated in an overall scheme.

In summary, a retail warehouse land use of the site would generate a high value, if an operator can be secured, as this would be a sought-after investment. However, the site is well located on the urban fringe, has excellent communication links, and is well placed to take advantage of a rising residential market.

In essence this is an example of a switching or exchange option, that is, the right to buy or take the better of two alternatives. This flexibility provides added value, through risk hedging between the alternatives (subject to a switching cost, that is, the costs of securing an alternative planning permission). The Real Options Super Lattice Solver software is used to ascertain various outcomes, which are then explained in the following text. A manual binomial calculation could also be undertaken but in this case would perhaps be more complex.

A five-step real options analysis (ROA) approach that was adopted comprised the following:

Stage I	Framing the problem
Stage II	Base scoping appraisal (deterministic)
Stage III	Internal and external uncertainty inputs
Stage IV	Real options (quantitative) analysis (stochastic)
Stage V	Explanations and making strategic decisions

Stage I: Framing the Problem

A switching option is another form of delay option, which comes under *flexibility* in the family of real estate development options. In framing this particular situation it is necessary to consider the dynamics of two real estate sectors, residential and retail, and, indeed, their cross-correlation.

A negative correlation provides greater risk diversification and, therefore, should increase the value of the switching option. The opposite is also true. In overall terms, evidence suggested a relatively high correlation between retail warehouse rental values and the level of activity in the housing market, but it was not conclusive, and there was also data to show the correlation varied over time (see Figure 11.58).

It is assumed (as was the case) that the site already has planning permission for a retail warehouse scheme of 140,000 square feet.

A real options analysis strategy matrix in respect to the two alternatives is presented in Table 11.34. From Table 11.34, subject to market factors,

TABLE 11.34 ROA Development Strategy Matrix—Switching Options (Retail Warehouse to Residential)

Strategy/ Approach	Market Factors	Planning Issues (residential)	Timing (development)	Embedded Option Appraisal
		Type of Development: Retail Warehousing or Residential		
Pessimistic	Weak demand from retail sector. Cyclical residential market issues.	Low rise housing with significant (35%+) social housing.	3 years plus (retail) 5 years (residential)	Switch or defer or sell
Cautious	Multiple occupier demand for warehousing but low covenant strength. Improving residential market.	Medium rise housing with 25% social housing.	2 years (retail) 5–7 years (residential)	Switch and develop or switch and defer
Optimistic	Uncertain occupier demand for warehousing. High-growth residential market.	High-rise or densely developed housing. 20% to 25% social.	2 years (retail) 7 years plus (residential)	Switch and develop

timing becomes a major determinant. Although this case study focuses on the switching option, it could also be combined with an option to wait (defer) or abandon or to expand (that is, a larger retail warehouse or residential scheme subject to planning/rezoning).

Stage II: Base Scoping Appraisal (Deterministic)

A standard development appraisal was undertaken in respect of both the retail and residential schemes of which the component elements are summarized in Table 11.35.

Development profit, that is, what a developer would require for the risk of implementing either scheme, is included in the gross development cost (GDC) in order to compare the like-for-like residual land values arising when brought back to the present day. From the foregoing it can be deduced that the static NPV of the switch is the NPV of the difference in the land values less the cost of the switch. In this instance this would equate to £2.53m. Although this would suggest the switch is in-the-money, it is only marginally so, and the two schemes are very different in terms of size and timescale. Is this enough of a reason to change? At what time would change be optimal? What is the current value to the owners of the land of having the ability to switch, now or at a later stage? Sensitivity, scenario, and Monte Carlo analysis may provide a guide to the overall risk structure, which could help quantify to some extent the first of these questions. A real options analysis is a more robust approach to answering these questions given an uncertain market in both sectors.

Stage III: Internal and External Uncertainty Inputs

Internal sensitivities are numerous with the site. It suffers from contamination, which raises some interesting embedded options particularly in respect of timing. This topic is not examined here, but optionality associated with contamination is a considerable area of practical application for ROA.

TABLE 11.35 Base Appraisal Components

Scheme	Retail	Residential
Size	140,000 sq. ft.	1,206 Units (302 social)
Gross Development Value	£34,820,000	£167,950,138
Gross Development Cost (excluding land)	£12,510,000	£135,031,871
Development Time Frame	2 years, 9 months	7 years (approximate)
NPV of Land Value	£18,758,251	£22,134,420
Cost of Switch	£844,121	

As with other real options examples, volatility is a key feature of the switching option. The residential sector, using land registry figures for Barking flats and comparing these to London flats and residential (as a whole) were analyzed. In addition, land transaction prices were analyzed over a similar period. Volatility levels were derived from these and summarized in Figure 11.56.

From the chart, average price volatility for apartment units from 1995 to 2002 for Barking was 11.49 percent. If different periods are taken into account, average volatility rates range between 4.83 percent and 20.21 percent. For the same period it can be seen that land price volatility averages only 3.81 percent for London as a whole. Land prices are notoriously difficult to measure (due to contractual overages and actual timing of payments) and, indeed, if outer London prices are considered on their own, these show an average price volatility of 8.42 percent. It is also a more notable feature of the market that land prices are increasingly correlated to unit price expectations at the time, notwithstanding there is not inconsiderable level of land banking in the U.K. market by developers (that is, developers will delay development until favorable periods for selling but hold the land at historic book value). For the purposes of this case study a volatility of 14 percent is adopted for the residential residual value reflecting the above and future market uncertainties together with a sensitivity range of 5 percent to 25 percent.

Retail warehouse (total return) volatility is indicated in Figure 11.57. For the purposes of this case study, 8 percent is adopted for the volatility of the

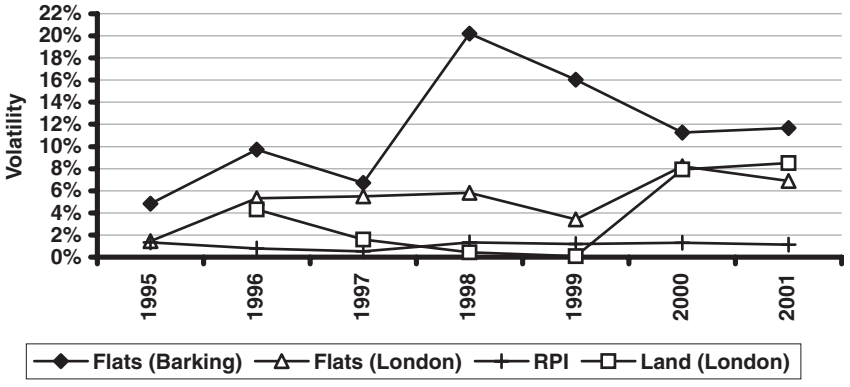

FIGURE 11.56 Residential Unit and Land Sales Volatility 1995 to 2001

Source: Gerald Eve Research.

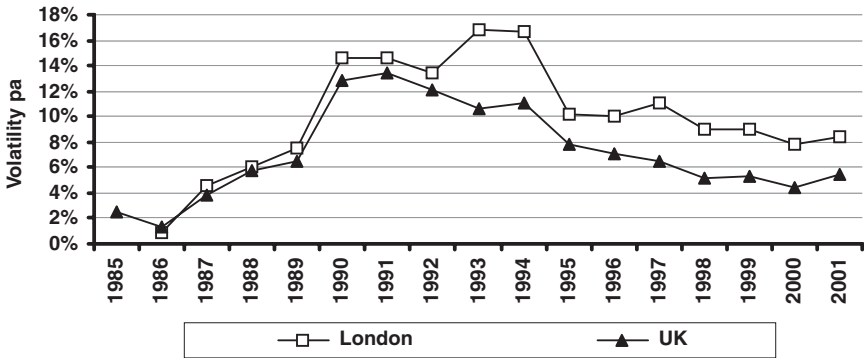

FIGURE 11.57 London and U.K. Retail Warehouse Volatility 1985 to 2001

Source: IPD.

retail residual land value reflecting the foregoing together within a sensitivity range of 5 percent to 20 percent.

The chart in Figure 11.58 provides an indication of the correlation between residential and the retail warehouse market. The synergy between the sectors produces an average positive cross-correlation coefficient of 0.61, which is used for the analysis. However, it is noticeable from the foregoing that there are times where the two sectors are less correlated than the 0.61

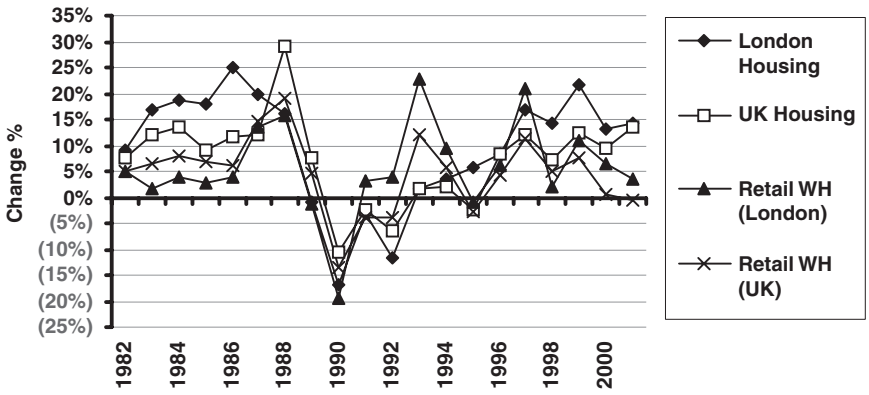

FIGURE 11.58 U.K. and London Retail Warehousing and Residential Correlation

Source: Gerald Eve Research.

would suggest. As previously indicated this would, all other matters being equal, increase the value of the switching option.

Stage IV: Real Options (Quantitative) Analysis

A calculation can be undertaken using the Multiple Asset Super Lattice Solver software with the following inputs: an underlying retail residual land price of £18.758M; a residential residual land price of £22.134M; volatility levels of 8 percent and 14 percent for retail and residential, respectively; a correlation coefficient between retail and residential of 0.61; a risk-free rate of 4.79 percent; three years to maturity (being the time frame in which the land owners would wish to make a decision to develop out either option having secured a residential consent); and cost of switching of £844,121 (being planning, consultants, and other costs).

The switching option value in this instance is calculated at £3.65M. The static NPV (as calculated under Stage II) was £2.53M as seen in Figure 11.59. Therefore the additional switching value created by an ROA is £1.12M.

Stage V: Explanation and Strategic Decision

From the previous section, it can be said that if the switching option is obtained, it is worth £1.12M. That is, the developer should be willing to spend

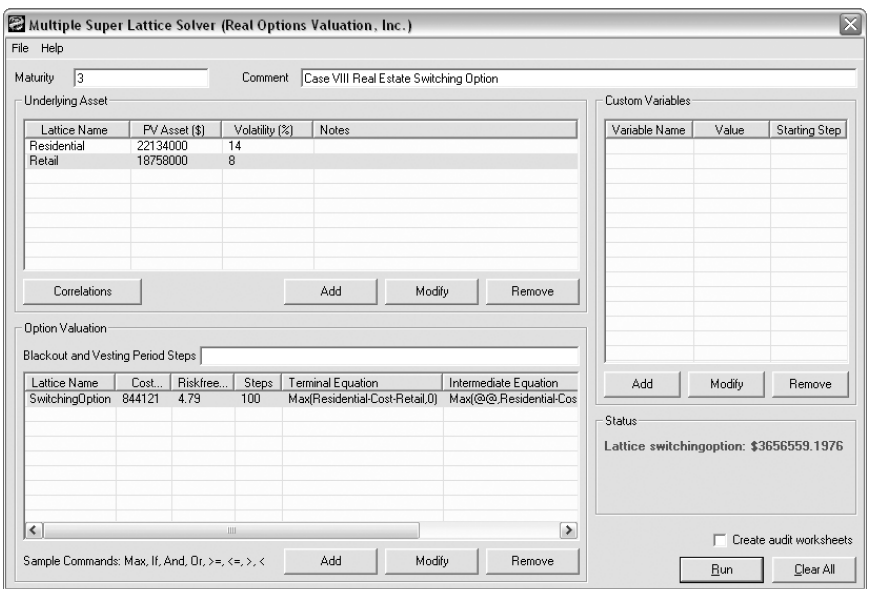

FIGURE 11.59 MSLS Solution to Switching Option

up to an average £1.12M to obtain the planning permission, the contamination cleanup and certification, and all other required legal documentation and requirements such that the option to switch from retail to residential can be executed. If such requirements are not obtained up front, a switching option may not exist. Therefore, the questions that were answered are how much the developer should spend to secure the strategic flexibility such that a new scheme can be implemented quickly and if such a switching scheme carries with it value. Additional real options analysis can be performed to determine the market value of the residential scheme such that executing immediately is valuable (the optimal trigger values and optimal timing analysis).

In real options analysis, if a sensitivity analysis in the form of surface area charts is undertaken, it will provide additional insights into the context of the results obtained. In this instance a Monte Carlo analysis is also provided in order to consider the risk profile and contributing factors to the results obtained.

It is interesting in this case to consider the payoff chart in comparing an option price NPV comparison as illustrated in Figure 11.60. As can be seen from the chart, even where there is a negative static NPV for residential, under a real options analysis there is value attributed to the option of switching.

Volatilities of retail in relation to residential are clearly shown, together with the combined effect, in respect to the switching value in the first of the charts in Figure 11.61. There are very noticeable "frowns" and "smiles" highlighting the importance of volatility analysis and the interaction of

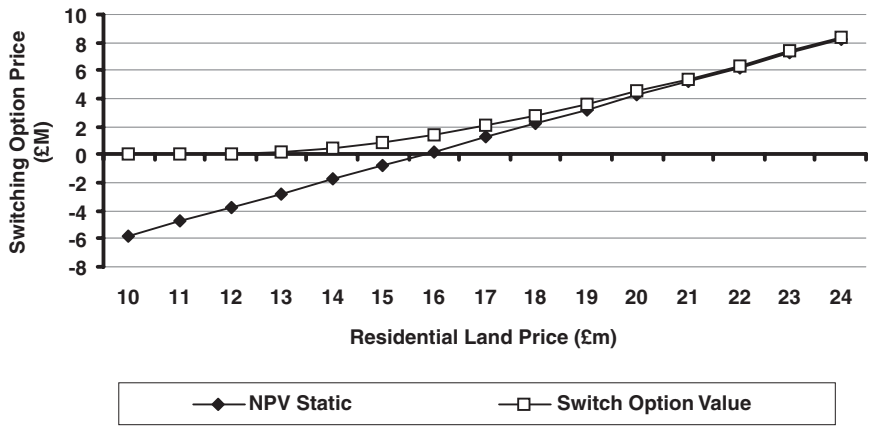

FIGURE 11.60 Switching Option Payoff Charts

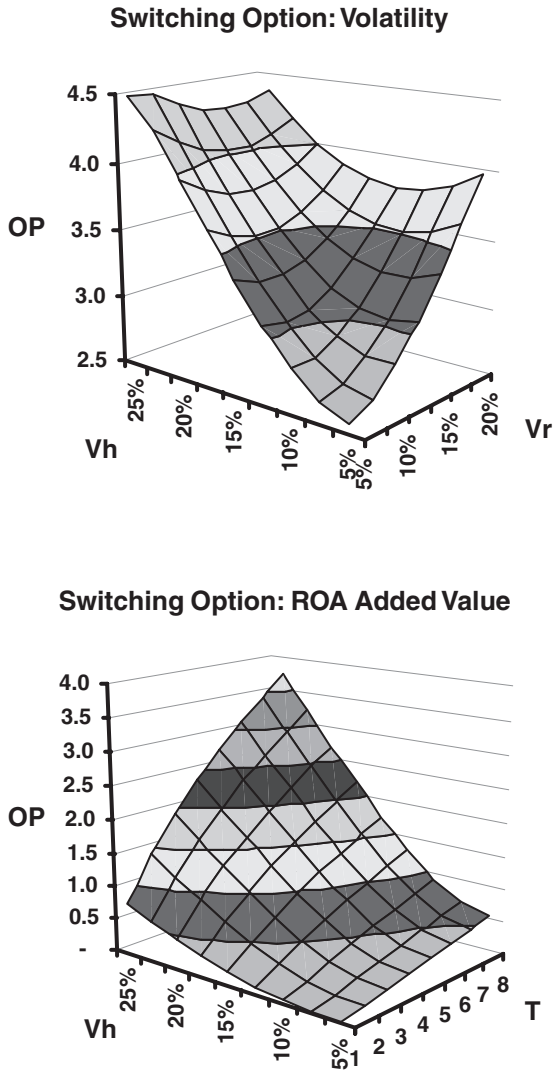

FIGURE 11.61 Sensitivity of Volatility and Timing for Retail and Residential

volatility between residential and retail sectors. Correlation between the sectors is therefore an important issue. In the second of the charts in Figure 11.61, it is also of note that the longer the time period, in this case, the greater the option price, which may suggest that an option to defer even at three years may be better for the land owner.

Finally a Monte Carlo frequency chart using the Risk Simulator software of the switching option price approach is shown in Figure 11.62 with a certainty level of 90 percent. The inputs comprised volatilities of residential and retail; their correlation, cost to switch, and time to maturity. There is a clear right skew and a mean of £1.18m value added above a static NPV as a result of the switch.

The investor, as a result of a real options analysis, can clearly ascertain the value derived from a potential switch notwithstanding that it is in-the-money, albeit only marginally so, on an NPV basis. A real options analysis has regard to future uncertainty with both residential and retail and their respective sensitivities. Again whether this would be enough to release a contingent claim and develop would in practice be subject to a closer assessment, based on optimal timing, having regard to the analysis performed and therefore a strategic decision on switching, now or at a later stage (subject to planning/rezoning).

This case study could provide for numerous other embedded options including the option to expand (or contract) the number of residential units or perhaps seeking an extension of the retail space (an expansion option); the option to phase either the retail or residential; the option associated with contamination mitigation (timing, deferral, or impact of switching); the ability to offset loss of earnings during construction through advertising and temporary use of land (subject to phasing) overcoming to a degree construction time lags; and to combine options (compound or spread options). Although this analysis raises some computational issues, in fully evaluating an appropriate strategy it can be seen that the foregoing analysis can be extended significantly in practice.

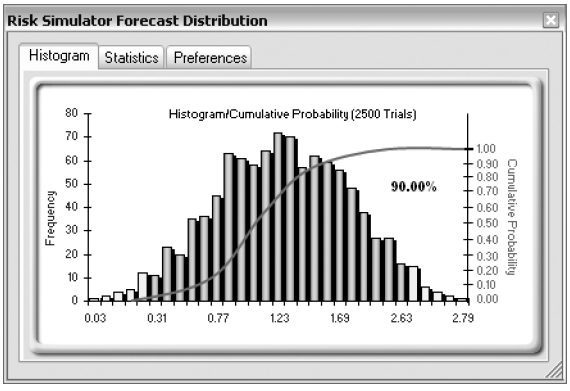

FIGURE 11.62 Real Options Analysis' Monte Carlo Simulation Results

Finally, when the two alternative development options were evaluated and presented against the perceived underlying strategic value of the site with these opportunities, management debate focused on market uncertainty in both sectors and the cost and timing of the switch. A real options analysis provided a quantitative and analytical backdrop for those discussions. The option to keep the ability to switch open until such a time when it was concluded optimal to pursue a residential development and, therefore, the contingent claim will then be exercised.

CASE 9: NAVAL SPECIAL WARFARE GROUP ONE'S MISSION SUPPORT CENTER CASE

This case study was developed by Sarah Nelson, Tom Housel, and Johnathan Mun. Nelson is the CEO of Intellectual Capital Ventures, LLC, a boutique consulting and valuation firm in Chicago, Illinois. Housel is a professor of information sciences at the Naval Postgraduate School in Monterey, California. Both Housel and Mun are strategic partners of the author's firm, Real Options Valuation, Inc., and the results of this project were presented to the Office of Force Transformation, Department of Defense. Proprietary and sensitive information have been removed but the essence of the real options application remains.

We developed the following case study for the Office of Force Transformation, Department of Defense (DoD), to demonstrate the power of applying real options analysis, populated with new raw data gathered using Knowledge Value-Added (KVA), to battlespace strategic planning initiatives. The quantitative analyses provided by pairing KVA and real options analysis enabled the DoD to better understand its return on investment in people and information technology for a technology-heavy mission support center. It also enabled the DoD to gain clarity regarding the many benefits of real options analysis for future planning purposes.

The Naval Special Warfare Group One (NSWG-1) of the United States Navy established and utilized a Mission Support Center (MSC) to assist in conducting mission planning and execution during Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). The MSC was a reach-back component, located in San Diego, California, that used information technologies to enhance the collaboration between forward and rear units and provided shared situational awareness for war planners and war fighters.

The MSC was designated NSWTG-REAR and was able to generate high-priority requests for information (RFI) that the intelligence community answered. Three new IT tools were also used as an integral part of MSC operations: