RISK AND OPTIMAL TIMING IN A REAL ESTATE DEVELOPMENT USING REAL OPTIONS ANALYSIS

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ABSTRACT

Risk and its management is key in most real estate investment and development opportunities. An addition to the techniques of understanding the risks and returns of a project is the application of a Real Options Analysis (ROA). Real estate contains a multiplicity of embedded real options due to its intrinsic nature. In particular, real estate development provides flexibility in deferring, commencing or abandoning a project, which in turn are options that convey value. A case example will be presented concerning a large site in the town centre of Croydon, 20 minutes from central London in the UK, and highlighting the differences of an investment's risk structure and average return when comparing a static NPV to an ROA approach. It will also illustrate the apparent irrationality of why land is left undeveloped in downtown locations despite the apparent redevelopment potential.

1 INTRODUCTION

Consideration of risk and its management is key in most real estate investment and development opportunities. Recognition of this, particularly in recent years, has led to various financial techniques being employed, including simulation analysis and value at risk (Var), to assess various proposed transactions. The UK Investment Property Forum has sought to establish a real estate sector standard for risk. This has provided a greater insight into the risk structure and returns of investments in order for management to review. Notwithstanding these approaches, they have nevertheless largely relied upon traditional deterministic appraisals as a basis for then assessing risk and return.

An addition to understanding the risks and returns of a project is by applying a Real Options Analysis (ROA). In commercial real estate, the application of an ROA to date has largely been academically driven (see References). Whilst this has provided a strong theoretical base with complex numerical and analytical techniques employed, there has been limited practical application. This in some respects is surprising, given that real estate contains a multiplicity of embedded real options due to its intrinsic nature and that the sector operates under conditions of uncertainty. In particular, real estate development provides flexibility in deferring, commencing or abandoning a project, which in turn are options that convey value.

The case example presented comprises a large site in the town centre of Croydon, 20 minutes from central London in the UK, and highlights the differences of an investment's risk structure and average return when comparing a static NPV to an ROA approach. It also illustrates the apparent irrationality of why land is left undeveloped in downtown locations despite the apparent redevelopment potential, an issue that has been the subject of several seminal real option real estate papers (see References).

The analysis in this case example is from the perspective of the investor in seeking to understand the optimal timing for development and risk structure associated. In order to maintain confidentiality and simplify certain steps, prices and issues referred to have been adapted.

The right or flexibility to develop (i.e. construct) land is a real option and this often comes in the form of an American Call option. This case example utilises a binomial lattice approach and methodology. The call option is combined with an American Put to sell the site either to the Council at Market Value (MV) or as a result of compulsory purchase order (CPO). Therefore, the strategic decision is whether to defer, sell (i.e., abandon) or develop. This flexibility conveys value, which is not captured by a conventional deterministic or NPV appraisal.

A five step ROA approach is adopted and comprised:-

- Stage I Mapping the problem
- Stage II Base scoping appraisal (deterministic)
- Stage III Internal and external uncertainty inputs
- Stage IV Real options quantitative analysis
- Stage V Explanation and strategic decision

Three quantitative variations using a lattice approach were considered: a binomial lattice; State Pricing; and a binomial lattice with two volatility variables. A Monte Carlo analysis was undertaken at both the deterministic (Stage II) and with the ROA (Stage IV), which further illustrates the risk profile comparison between real options and NPV.

The lattice approach, allows for decisions to be taken at each node. This provides an investor with the ability to determine the optimal timing in respect of development, or to defer, or to abandon (disposal of the property).

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

- An undeveloped town centre site of approximately 2.43 ha (6 acres) adjacent to a major public transport interchange;

- A comprehensive mixed use scheme has been granted planning permission comprising: a supermarket (7,756 sq m, 83,455 sq ft); retail units (6,532 sq m, 68,348 sq ft); restaurants and bar (7,724sq m, 83,110 sq ft); health club and swimming pool (4,494 sq m, 48,355 sq ft); Night Club (3,718 sq m, 40,006 sq ft); Casino (2,404 sq m, 25,867 sq ft); Offices (12,620 sq m, 135,791 sq ft); and car parking (500 spaces);

- The investor acquired part of the site (in a larger portfolio acquisition) at a book (accounting) cost of £8m, reflecting the development potential. It also inherited option agreements with other adjoining landowners in order to assemble the entirety of the site, which would result in a total site acquisition cost of £12.75m, thereby enabling the implementation of a comprehensive scheme;

- The costs of holding the site and keeping the options open with the other landowners are £150,000pa. Income from car parking on the site is £50,000pa. Therefore, net outgoings are £100,000pa (totalling £500k over five years i.e. assumed to be an intrinsic sunk cost in developing the site);

- The Council wish to see the site comprehensively developed for the scheme and have granted permission. They also have a long held objective of developing a sports and entertainment Arena in the centre of Croydon. Under an agreement with the investor in conjunction with granting the planning permission, the Council has said it would acquire the land at MV (i.e. equivalent to the book cost) at any time up to 5 years from grant of planning permission should the investor wish to sell and not implement the scheme. Thereafter the Council would acquire the site using CPO powers (a statutory procedure) if comprehensive development has not been started. The case for granting a CPO is believed to be strong given, amongst other reasons, the fragmented ownership and that this high profile site has lain undeveloped for many years. Compensation from the Council to the Fund in acquiring the site via a CPO based on a *'no scheme'* world (i.e. ignoring any development potential) has been calculated at £5m.

2 STAGE I: MAPPING THE PROBLEM

Three basic real options were identified that conveyed *'flexibility'* in terms of optionality in real estate development. They were: the option to abandon (i.e., sell); the option to defer investment; and the option to execute (i.e., implement the development). Any of these should be exercised prior to the expiration of 5 years given that the site would be compulsorily acquired at what the investor estimated as being at sub book value under a CPO. In addition to these options could also be added the option to alter the planning permission subject to market circumstances. Whilst this would often happen in practice, it is not examined in this instance. The optionality of achieving an optimal tenant mix could also be considered.

These options are American (two Calls and one Put), although the decision just prior to the expiration of five years or the CPO could be considered a European Put and therefore should be calculated as such.

The Croydon market was considered uncertain in terms of occupier requirements and rental levels, which were sensitive to general real estate market movements for both offices and retail. The ability to attract a supermarket operator and a major office pre-let were seen as key pre-requisites prior to implementation of construction. The scheme would not be developed speculatively.

An ROA strategy matrix was prepared. Table 1 provides a simplified summary:

Table 1: ROA Development Strategy Matrix

Strategy/ Approach	Type of Development	Market Factors	Planning Issues	Timing	Embedded Option Appraisal
Pessimistic	Comprehensive Development	Poor office market uncertain retail requirements	Reduce office content. Reconfigure retail	3-5 yrs	Defer or Sell
Cautious		Occupiers require 50% of offices. Anchor retail tenant but at low rent	Consider phasing offices and retail (review planning gain obligations)	2-4 yrs	Defer or develop/ Expansion option
Optimistic		Major office pre-let Quality anchor retailers secured. Demand is high for all uses in the scheme	Consider increasing office content	1-3 yrs	Develop and expansion option

It was evident from the above that even in applying a qualitative analysis, values may evolve asymmetrically. There could be a considerable upside relative to the downside. It was a characteristic of the Croydon office market for example that other competitor office schemes if implemented could encourage office sector activity and upward pricing of space with a high probability of occupier relocations. In this instance the investor did not have other real estate holdings in the town centre. If it did implementation of the scheme may also be considered a strategic (growth) option and could be analysed as such.

3 STAGE II: BASE SCOPING APPROACH

A cash flow residual development appraisal was produced, with key value drivers of the scheme being the supermarket and office components accounting for 47.15% of the expected capital value of the entire project. An overall blended yield of 7.8% was expected, which in market terms was considered cautious. An office rent of £215 per sq m (£20 per sq ft) was applied although this was considered to have under performed London office (and UK) office growth. Total office returns also under performed London (and the UK), which is in line with historic patterns for Croydon.

Costs comprised of: land acquisition; construction; professional fees; other agents fees & costs; and finance (rolled up interest on costs).

Land and construction costs excluding profit totaled £90.48m. The Gross Development Value (GDV) of the scheme was £105.76m. It was considered by the investor that for a project of this scale that a developer's profit on cost of 17.5% would be required (although profit on land was accepted at 10%). The scheme on this basis outlined above was marginal producing a total profit of £15.28m. In other words, a deterministic (NPV) measure of development profit.

A Monte Carlo simulation analysis was undertaken based on key input variables of: supermarket and office rents and yields; and office construction costs. This showed a mean total profit return of £13.7m (90% certainty range of £8.4m to £17.8m) against a minimum required return of £14.7m (assuming 10 % and 17.5% profit on land and construction cost respectively). This can be compared with the ROA and explanation, which incorporates a simulation of the option values in Table 3 below.

4 STAGE III: INTERNAL AND EXTERNAL UNCERTAINTY INPUTS

The base scoping provided a useful measure of the financial internal uncertainties and their inter-dependencies. In practice it is necessary to have regard to specialist reports concerning construction constraints, cost variables and programming.

An ROA requires an assessment of volatility, being a key input into the risk neutral framework of real options pricing. In this instance State Pricing was also used. An assessment of the magnitude of the upside and downside within an underlying lattice in order to capture the likely asymmetry of the Croydon market was therefore undertaken.

As volatility is key to ROA, research and subsequent analysis are critical in obtaining suitable input data and then reviewing the resultant computations in Stage V. Indices, as outlined below are based upon professional valuations as opposed to market transactions. Academic papers have highlighted the potential for what is known as valuation "smoothing" within the indices with the result that volatility of real estate may be understated. Various techniques and data sources have been used for backing out true, historic, implied and expected volatility in real estate over alternative timeframes. This however remains a significant area of research. The approach below has been simplified for practical reasons in obtaining appropriate volatility rates for this case example.

The UK Investment Property Databank (IPD) data on office and retail rental growth and total returns for Croydon, London and the UK between 1981 and 2002 was analysed. As investment performance is judged on total returns it was these volatility figures, which were used in respect of the underlying asset value. Volatility of total returns for office and retail for

three periods: 1981-2002(1); 1991-2002(2); and 1995-2001(3). These show volatility decreasing over the three periods from a range of 8.6% to 12.1% (offices) and 6.4% to 8.7% (retail) to 2.4% to 3.3% (offices) and 1.15% to 3.4% (retail). These appear to be low volatility rates compared to empirical research (see References).

Another way of considering the volatility over this period for offices and retail is on a five-year rolling basis. From this the Croydon office market showed an average volatility of 8.95% (range 2.2% to 14.7%). This was below both London (average 11.39% - range 4.1% to 24.1%) and the UK (average 10.12% - range 2.6% to 10.9%).

For retail (except in Croydon) the volatility levels were generally lower than offices with the Croydon market showing an average of 10.27% (range 3.2% to 18.9%) compared with a London average of 9.29% (range 3.5% to 19%) and the UK average of 7.46% (range 1.5% to 14.3%).

It is necessary for the underlying asset to arrive at a single volatility, i.e., combining retail and offices. Further research and analysis in practice was undertaken including cross correlations. For the purposes here a figure of 10% with an analysis range of between 5% and 35% is utilised. This upper level takes account of sector empirical studies and de-smoothing of base indices.

So far as the price probability under State Pricing, this has regard to compounded growth in capturing the asymmetry of future underlying asset changes. Again further research in practice was undertaken. Indeed, an alternative approach in option pricing would be via a jump-diffusion where by an initial jump (i.e., upside) could be followed by a reversion to appropriate volatility levels. Non-recombining lattices or multiple recombining lattices with changing volatilities could also achieve similar results. For State Pricing the upstate was assumed at 15% and downstate 5%.

So far as costs were concerned: cost inflation was set at 5%; and cost volatility at 5%. The latter was considered low in comparison to empirical examples and therefore, was analysed within a range of 5% to 25%. UK published construction cost indices have been criticised as not reflecting the true volatility found in the sector. This has again led to other alternative measures and proxies being sought and analysed including traded call options of construction companies.

5 STAGE IV: REAL OPTIONS (QUANTITATIVE) ANALYSIS

The three lattice approaches together with the inputs and assumptions outlined above were computed. The cost (implementation) input excluded profit, on cost and land, in order to directly compare the option price to development profit. The value input was that derived from the deterministic appraisal. Under each approach the lattices were as follows:

- An underlying price lattice, the price evolution;
- An underlying cost lattice, the cost growth or evolution;
- The value of exercising the development, in simple terms the NPV in each moment of time of making an investment;
- A valuation lattice where the value would be the maximum of: the price less costs; the option to defer less the intrinsic sunk costs; or the offer to acquire by the Council. The termination boundary (year 5) would be maximum of the underlying price less costs or the offer to acquire by the Council; and
- A decision lattice, which was based upon the valuation lattice in determining at each node whether to defer, sell or develop.

Option values were calculated under each of the three approaches, which were then compared to the development profit of the deterministic approach, as shown in the following table.

Table 2: A Comparison of Real Option Values with NPV

NPV	ROA		
£m	**Binomial £m**	**State Pricing £m**	**Binomial (Dual Volatility) £m**
15.28m[1]	18.13m	18.09m	23.77m
Additional value created by ROA	2.85m	2.81m	8.49m

1. This represents the total profit of investing now of which £14.7m would be the minimum required return.

In each case the value (Profit) of the option to defer (i.e. now or later) is higher than the current or expected profit of investing immediately. The difference in the real option values results from the evolution of the lattice and risk neutral pricing of each approach.

6 STAGE V: EXPLANATION

The option price takes in to account all possible future outcomes under the three ROA approaches that was not captured by the deterministic analysis. It was however, necessary to consider the sensitivity of the inputs particularly in respect of volatility (price and cost) and price probabilities under State Pricing as well as the impact upon the decision lattice at the different nodes.

Figure 1 shows the decision lattices (with time in years in bold) are set out for comparative purposes:

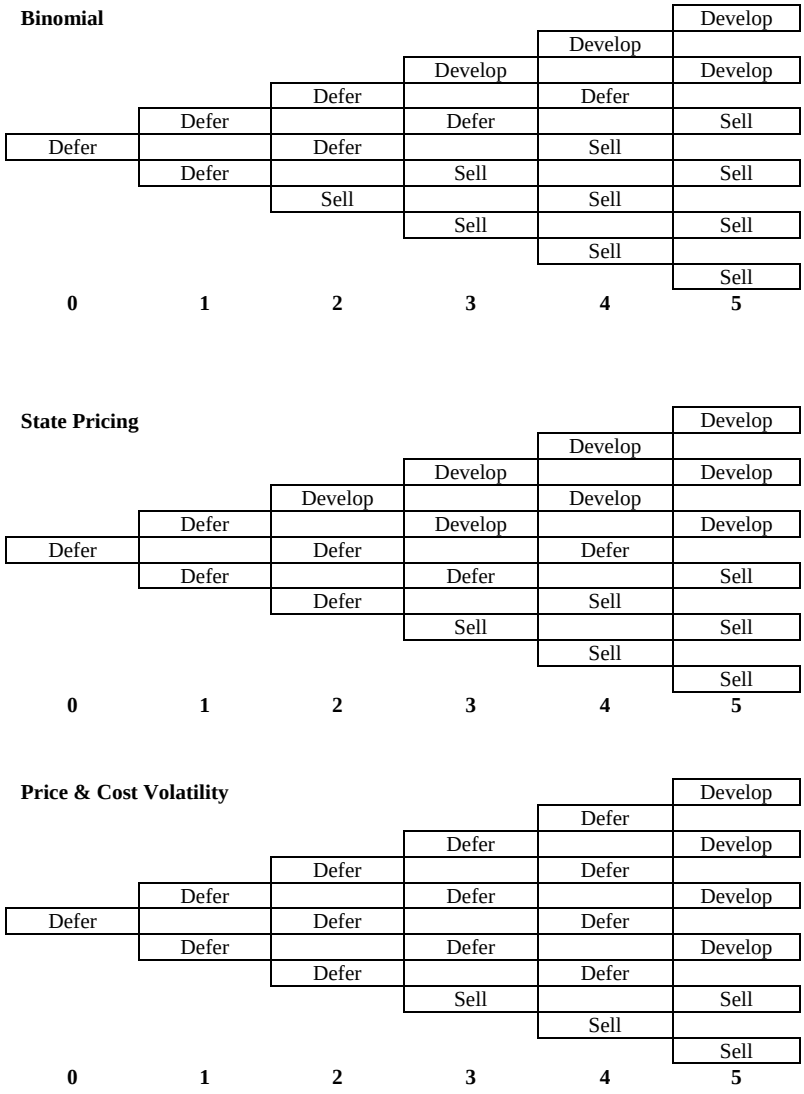

Figure 1: Decision Lattices

Taking an overview having regard to all of the approaches: development would probably be deferred in years 1-2; deferral or selling were the dominant options in year 3; and development would only probably be envisaged in years 4 or 5. This essentially provides, an analytical underpinning for a professional judgement and decision framework.

A sensitivity analysis clearly indicated the effect and interaction of volatility upon the option price which again emphasised the importance attached to establishing base volatility inputs as discussed in Stage III. A Monte Carlo analysis of each option price was undertaken with a certainty level of 90%. These could be compared to the base scoping analysis and illustrated the narrowing (particularly with State Pricing) of the risk structure and higher average return as shown in Table 3.

Table 3: Simulated NPV and Option Values Croydon (Average & Range)

	Average Return £m	**Risk Structure Range 90% £m**	**% Above Required Return**
NPV	13.7	8.3 – 19.0	(6.8%)
Binomial Lattice	21.1	16.2 – 26.2	43.5%
State Pricing	20.6	17.3 – 23.4	40.0%
Binomial (Cost/Price Volatility)	25.1	18.6 – 31.1	70.7%

It was notable that the risk structure range downside of the three approaches was relatively similar being between £16.2m and £18.6m. In this particular instance the downsides provided useful benchmarks to the minimum required return of £14.7m under an NPV approach, as an alternative measure to comparing average returns. Notwithstanding this, the upsides under the three approaches were significant.

The investor, as a result of a ROA, can clearly form a strategy in terms of optimal timing or whether to invest at all. The flexibility of this created additional value over and above a conventional valuation of the development. This would perhaps be incorporated within a price, if the investor were, say, to dispose of the opportunity to a third party at the beginning of the period.

The real option paradigm when applied to real estate potentially highlights, on one hand the seemingly intuitive action of investors and, on the other, under-valued investment opportunities and sub-optimal decisions. As such a ROA, as illustrated above, therefore provides another approach and layer to the risk analysis and potential returns of real estate investment and development.

REFERENCES

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BIOGRAPHY

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