Discounted Cash Flow: Accounting for Uncertainty

Nick French and Laura Gabrielli

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Abstract

Valuation is the process of estimating price. The methods used to determine value attempt to model the thought processes of the market and thus estimate price by reference to observed historic data. This can be done using either an explicit model, that models the worth calculation of the most likely bidder, or an implicit model, that that uses historic data suitably adjusted as a short cut to determine value by reference to previous similar sales. The former is generally referred to as the Discounted Cash Flow (DCF) model and the latter as the capitalisation (or All Risk Yield) model.

However, regardless of the technique used, the valuation will be affected by uncertainties. Uncertainty in the comparable data available; uncertainty in the current and future market conditions and uncertainty in the specific inputs for the subject property. These input uncertainties will translate into an uncertainty with the output figure, the estimate of price.

In a previous paper, we have considered the way in which uncertainty is allowed for in the capitalisation model in the UK. In this paper, we extend the analysis to look at the way in which uncertainty can be incorporated into the explicit DCF model. This is done by recognising that the input variables are uncertain and will have a probability distribution pertaining to each of them. Thus buy utilising a probability-based valuation model (using *Crystal Ball*) it is possible to incorporate uncertainty into the analysis and address the shortcomings of the current model. Although the capitalisation model is discussed, the paper concentrates upon the application of Crystal Ball to the Discounted Cash Flow approach.

Nick French, Senior Lecturer in Real Estate
and Jonathan Edwards Consulting, *Fellow in Corporate Real Estate*
The Department of Real Estate & Planning, The University of Reading Business School
Whiteknights, Reading, Berkshire, England, RG6 6AW
Tel: +44(0) 118-931-6336 e-mail: N.S.French@reading.ac.uk

Laura Gabrielli, Contract Professor in Property Valuation
IUAV Venice University of Architecture
Urban Planning Department, Dorsoduro 2206 - 30123 Venice, Italy
Tel: +39(0) 41-257-1387 e-mail: gabriel@iuav.it

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"Common professional standards and methods should be developed for measuring and expressing valuation uncertainty."

Recommendation 34, Mallinson Report, RICS[1] 1994.

Introduction

The purpose of any Valuation is to determine the present value of a future cash flow. The value of an investment is the discounted value of all estimated future liabilities and benefits. Value is therefore based on future forecasts, which can be modelled either implicitly or explicitly. Only in cases where there is a predetermined fixed cash flow (rent) can a valuation be considered to be "correct". Even, then the risk of non-payment of rent; the impact of the reversion or unforeseen expenses incurred limits this to a "best estimate". In cases where the cash flow is subject to variation (growth), this "best estimate" becomes less certain. Thus, valuations are uncertain.

The more accurate the future expectations the more robust the valuation. This highlights the importance of dealing with future expectations in the valuation process and suggests that the adoption of multiple scenarios will greatly facilitate the valuer in providing sound competent professional advice.

For any valuation or appraisal method to have validity it must produce an accurate estimate of the market value or price of the property investment. Implicit valuation (or capitalisation) models can be valid models as they, in most markets, produce accurate estimates of price. The advantage of an explicit model is that it forces the valuer to question all inputs in the model.

In the context of this paper, we are not proffering that one method is better than another. Indeed, French (1997) stresses that the important factor in the valuation process is using the method that is appropriate for the valuation problem in hand. Sometimes, an implicit model is the most appropriate; sometimes the explicit model. The premise of this paper is that, regardless of method chosen, all valuations are subject to uncertainty. The sources of uncertainty are rational and can be identified. Uncertainty can be described in a practical manner and it should be conveyed to clients in an understandable format. This will improve the content and the credibility of the valuer's work.

1 Royal Institution of Chartered Surveyors

Uncertainty in Valuation

Uncertainty impacts upon the valuation process in two ways; firstly the cash flows from investment are, to varying degrees, uncertain and secondly the resultant valuation figure is therefore open to uncertainty. This paper builds upon the analysis undertaken with the implicit model (see French and Gabrielli, 2004) by using a generic forecasting software package, *Crystal Ball*[2], which allows the valuer to work with familiar explicit pricing models set up in Excel. It looks at how uncertainty can be accounted for in the valuation and how it can be reported to the client in an effective and meaningful way.

Uncertainty is a universal fact of property valuation. All valuations, by their nature, are uncertain. Yet they are generally reported to the client as a single point estimate without reference to the context or the uncertainty underpinning them. This paper argues that it is possible to inform the client of the reality of uncertainty without impugning the utility of the valuation. In the UK, there has been significant discussion and debate on this topic. The most recent report on valuation from the RICS, the Carsberg report (RICS, 2002) stressed that ways should be sought to establish an acceptable method by which uncertainty could be expressed in the valuation. The terms of reference of this report and other discussions are summarised in French and Gabrielli (2004).

It should be stressed that this paper is concerned with value. That is the best estimate of the price of the building in the market on the date of the valuation. The valuation attempts to identify and estimate all the benefits and liabilities of ownership and, relative to the current market, assess the highest and best bid for the property. As with all markets, a property will be offered to the market and individuals will bid for its purchase. The property will trade at the highest bid, not at the level where there are most bids (see Peto, 1997). The valuation attempts to identify this figure; this is an estimate of price.

Each possible bid for the property will be determined by the bidders particular circumstances. Each will carry out a 'calculation of worth', which is the individual bidder's assessment of worth to them. It will be dependant upon the particular bidders assessment of the property and their own forecasts of the benefits of ownership. A calculation of worth is not a valuation and thus this is not considered in this paper. For a full explanation of the difference between Valuation Methods and Calculation of Worth see the RICS Information Papers of the same names (1997 a/b).

[2] An alternative would be to use @risk which is a very similar software package

Implicit Valuation Models

One of the paramount concerns of the profession is the need to ensure that valuations are presented to a client in a clear and unambiguous manner. Given that clients are becoming more sophisticated in the way they determine whether to buy or sell property, then the pricing model used to assess the most likely exchange price should reflect their thought process to the extent that this influences the market. In using the traditional implicit capitalisation model, the valuer is deriving the appropriate all risks yield (initial yield) from market evidence of other property transactions. The all risks yield is a convenient measure for the analysis and valuation of similar rack-rented investments. Effectively, the all risks yield states that such investments customarily sell for a certain multiplier (the YP[3]) of the rental income. Adjustments to the all risks yield to reflect differences between comparables and the subject property are made subjectively. Although based on comparison, the all risks yield method does implicitly reflect rental growth, obsolescence and the resale price.

As the all risks yield is adapted to reflect differences between comparables and the subject property, it has to reflect a multitude of factors from return on capital, security of income, ease and cost of selling, management costs, depreciation and rental growth. Where there are sufficient sales transactions on similar properties in the market, it is possible to build up a picture of market sentiment to be reflected in the choice of an appropriate all risks yield for the subject property. It is therefore possible to undertake a valuation without explicitly addressing the input variables discussed above. The valuation is simply a multiplication of the current rent and no explicit consideration is given to the impact of each of the component parts on the final value. We can illustrate this by reference to a rack rented freehold office property. Similar investments are selling All Risks Yields around 5%. The valuer's assessment is that this does not require any adjustment, as the characteristics of the subject property are very similar to that of the comparables available. Thus the valuation uses an All Risk Yield of 5% on the Market Rental of £10,000. This produces a capital value of £200,000 as illustrated in Figure 1.

Implicit (All Risk Yield) Capitalisation Model

Market Rent	£10,000
YP perp @ 5.00%	20
Capital Value	**£200,000**

Figure 1: Implicit Valuation

3 The Year's Purchase is the reciprocal of the All Risks Yield.

Here it can be seen that the all risk yield produces a multiplier (YP) of 20, which is applied to the current market rent of the property. This rent is expected to increase over time yet the valuation makes no attempt to quantify this expectation. Likewise, there is no indication of the holding period or the overall required rate of return etc. The All Risks Yield includes all these factors but implicitly. Effectively is an all-encompassing aggregation and thus no one variable is considered individually but only as part of the overall attractiveness of the investment.

Explicit Valuation Models

The basis of the Discounted Cash Flow valuation is that the value of the property investment will be equal to the Gross Present Value (GPV) of the projected rental income flow, at the market's required rate of return (discount rate). The advantage of the Discounted Cash Flow technique is that it makes the valuation more "transparent". It makes explicit the assumptions (market expectations) on future rental growth, holding period, depreciation, refurbishment, redevelopment, costs of management and transfer, taxation and financing arrangements and thus by making these assumptions explicit, it will allow us to question the certainty of each of the input variables.

It should be stressed again, that we are not advocating the discontinuance of using the implicit method where appropriate. What we are doing is to analyse the hidden assumptions implied in the all risk yield method and by so doing question the certainty of each assumption.

The Discounted Cash Flow technique, as applied to property, has developed in response to the perceived shortcomings of the all risks yield method, which, although a useful method of analysis and pricing, fails to explain the implicit assumptions contained within it. But each method is trying to assess price. Where there is substantial market information and where the property type is traded extensively, the two methods will produce the same value. Again, we can illustrate this by reference to the example in Figure 1, which had a Market Rent of £10,000 and an All Risks Yield of 5%.

The All Risk Yield method implies growth and, although not stated, it must be doing so at a certain level. This can be analysed by reference to investors' overall required return from this type of property. Most property investors (particularly of prime rack-rented property) will know the level of return they require; remembering that the All Risks Yield is only an initial return figure. Thus, by analysing the market we can determine that investors are requiring an overall return of 8% for this type of property[4]. This is called the Equated Yield. Knowing this, there must be a relationship between the three variables

[4] Retrospectively this would be viewed as the total return (income return plus capital return over defined investment period).

(initial yield, overall yield and growth). In simple terms, in one year, if an investor accepts an initial return of 57%, but requires an overall return of 8%, then the income must grow by 3% (return) over the year for the 8% return to be reached. This growth is equal to the difference between the overall return and the initial return. In practical terms this growth may either be in the form of an increase in the income flow over the period of the investment, and/or an increase in its capital value. The simple annual growth calculation of deducting the initial yield from the required overall yield is only true where incomes change annually. With UK property, the rent review pattern means that not only does an investor need a certain level of growth each year, as above, but the investor also needs additional growth to compensate for every year that the income is fixed. The formula in Figure 2 calculates this total growth requirement at any given initial yield, overall discount rate (equated) yield and rent review pattern. Thus at 8% equated yield (e) and 5% initial yield or ARY (k) it can be calculated that the annual growth requirement (g) would be 3.30%.

Effectively, an investor accepting an initial return of 5% would require 3.30% growth in rental income on average each year (compounded at each rent review) to achieve an overall return (equated yield) of 8%. This does not mean that this is the growth pattern that will actually happen, it simply indicates the level of consistent growth that is required if the investor is to achieve the required target rate at that price. If growth turns out to be lower that this linear average figure, then the investor has paid too much for the property. If growth turns out to be above 3.30%, then the investor will achieve an overall return of above 8%. In the analysis the expected growth is reflected in the income flow, however in practice, there may be accompanying changes in the future exit yield (ARY at resale) over time, which may lead to an increase or decrease in the capital value at resale.

FORMULA		**k = e - (SF x p)**
k	=	Initial Yield (All Risk Yield)
e	=	Equated Yield
SF	=	ASF[5] @ e for R/R period
p	=	% Growth over Rent Review (rr) Period
g	=	% Annual Growth
0.05	=	0.08 - 0.1705 x p
p	=	17.60%
g	=	3.30%

Figure 2: Calculation Of Annual Implied Growth

5 The Annual Sinking Fund formula = e/((1+e)^rr –1)

Explicit Discounted Cash Flow Model

YEAR	RENT	YP @ 8.00%	PV @ 8.00%	PV £
1 - 5	£ 10,000	3.99		£39,927
6 - 10	£ 11,760	3.99	0.68	£31,956
Sale	£ 13,830	20.00[6]	0.46	£128,117
		Capital Value		**£200,000**

Figure 3: Explicit Valuation

Having determined the equated yield and implied growth, the Discounted Cash Flow method can mirror the All Risk Yield approach by explicitly applying all the assumptions that have been implicitly allowed for in the capitalisation model. It has been assumed that the lease is for 10 years and that the holding period is the same duration. Similarly, the rent has been increased by 3.30% (compounded) at each rent review/lease end to allow for the growth explicitly and the resulting cash flow has been discounted at the market equated yield of 8%. It is the role of the valuer to provide the professional judgement to determine those assumptions and in turn provide the "best estimate" of value, which in both models is £200,000.

The process of analysis is the same as with the capitalisation method. Each assumption is derived from comparison suitably adjusted by the same professional judgement of the previous valuation. The valuer will use the assumption figure that is believed to be most appropriate (most probable?) but there will not be, in any market, a 100% confidence in each of the input assumption used. There will be a degree of uncertainty pertaining to each of the inputs. The future is uncertain and each input assumption captures market expectations about the future. It is the thesis of this paper that this uncertainty should be explicitly conveyed to the client. Acceptance of the fact that the valuation is uncertain is not an abdication of professional judgement but, instead, a useful addition to the process as it allows the valuation user to place the valuation figure in context.

In both models, the currency of analysis is current market. Both models give an indication of price based on market expectations decanted from that analysis. Understanding the strengths and weaknesses of the data used is as

6 Note that the YP used at the predicted sale in 10 years time is calculated assuming that today's ARY is applicable at the point of resale. Thus a 5% ARY is used, giving a YP multiplier of 20.

important as obtaining the data itself. Market valuations need to use market information and any projections used will reflect *market* expectations of future changes to the income cash flow and/or expected movements in the exit yield over time. We will refer to these estimates as *Expectations. O*nly Calculations of Worth will use client specific information and such estimates will be referred to as *Forecasts*. However, this paper is concerned with valuations and as such, we will restrict an analysis to the uncertainty pertaining to *Expectations*[7].

Valuation and Uncertainty

For the purposes of this paper we are seeking to identify the characteristics of the uncertainty that lies in the valuer's mind when assessing the estimates of the inputs involved in the Discounted Cash Flow model. This will still produce a single valuation figure, but by analysing the uncertainty relating to the inputs used in the model, it will allow the identification of the uncertainty related to that specific single valuation figure.

Uncertainty is due to the lack of knowledge and poor or imperfect information about all the inputs that can be used in the valuation. Unless the input variables are certain then the resulting outcome (value) is also uncertain. This is a different concept to risk. Uncertainty is anything that is not known about the outcome of a valuation at the date of the valuation, whereas risk is the measurement of the value not being as estimated. If we are able to assign a probability to the input variables it will allow us to determine the range of possible outcomes. The output is therefore a measure of risk (Byrne, 1996).

In the previous paper (French & Gabrielli, 2004), we have discussed the nature of probability distributions that can be applied to each variable. Whilst it was recognised that the normal distribution was the most statistically robust, it was argued that the triangular distribution was a more appropriate approximation of the thought process of a valuer. Valuers tend not to conceptualise uncertainty in the form of standard deviations around a mean. Instead, they think in terms of "most likely" figure, the "best" and the "worst". This is a triangular (3–point) distribution. In other words, once the valuer has determined the most likely input, as used in both of the static models above, it would be possible for them to quantify their uncertainty on each variable by asking them what they believed that the corresponding best and worst figures could be. If there is sufficient market evidence, the valuer will feel more certain of the market conditions and thus more confident in most likely figure for each variable and thus the best and worst may not deviate significantly form this figure. However, where there is less market information, there will be

[7] Crystal Ball analysis is equally applicable to calculation of worth, however, the question being addressed in such analysis would be the uncertainty of the GPV to a particular investor; this is very different to assessing the uncertainty in value. Calculation of Worth is not considered in this paper.

more uncertainty and the corresponding range, above and below the adopted figure, will be proportionally higher than the pervious range. Thus the triangular distribution will be adopted in our analysis.

The Simulation Process

Crystal Ball is a simulation model (using the Monte Carlo technique) that, instead of taking one defined set of input figures and producing a single point answer (value), carries out multiple calculations via an iterative re-sampling process. Each simulation chooses an input variable from within the probability distribution chosen for each variable and marries these with other randomly chosen inputs to produce a value. It then recalculates another value by the same process and records that value. This is then repeated, normally several thousand times, until the simulation is complete. The output is expressed as a range of possible values with the single point estimate being the mean of all the calculated values. This process is shown graphically in Figure 4.

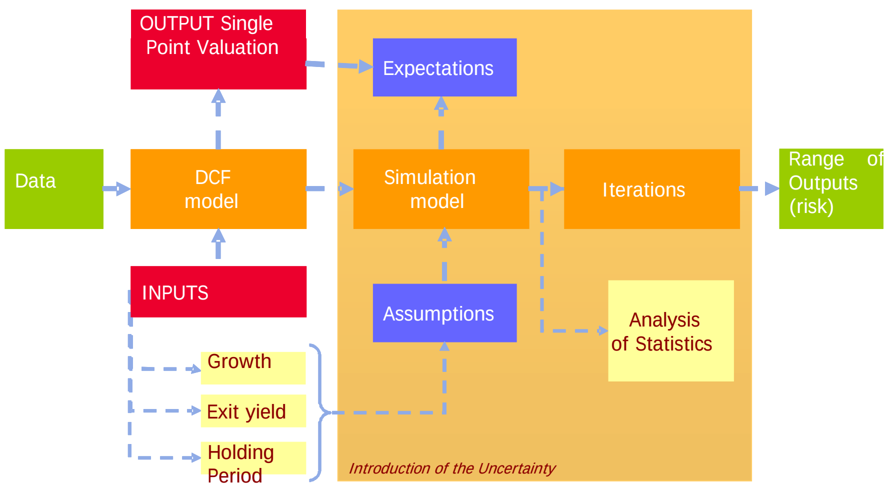

Figure 4: The Simulation Process

As we know, the explicit Discounted Cash Flow model and the implicit capitalisation model will produce the same capital value. However, the DCF model incorporates more variables and, as such, in terms of uncertainty this increases the need for analysis of the inputs. The *Crystal Ball* technique allows us to incorporate uncertainty into the analysis in a relatively simple form. Because each input variable is defined at random from the user defined probability density function, it allows us to model a range of possible outcomes. No one output is certain, but given the certainty that we have ascribed to each variable (see Figure 5), some are more certain than others. This is reflected in the fact that the sampling will take figures at random from each probability range and thus more numbers will be taken near the most likely input figure which will feed through to the range of outputs (see on). It is also possible, and important, to account for any correlation between the chosen variables (see Figure 5). For this case study, the following assumptions about the inputs were chosen:

Input	Distribution	Mean	Min	Max
Rental Growth	Triangular	3.30%	4.5%	2.5%
Exit Yield	Triangular	5%	4%	6%
Holding Period	Triangular	15 years	5 years	25 years
Equated Yield	Triangular	8%	7.75%	8.25%

Figure 5: Probability Distributions of Chosen Variables

In the figure 5, the mean (most likely) figures are determined by an analysis of the market. The minimum (worst) and the maximum (best) values are the valuer's judgement of these parameters. Note that in the case of the Exit Yield that as this the forecast of the expected ARY at sale, the relationship is inverse. A lower yield suggests a better resale value. Hence, although the maximum is expressed as a higher yield, this is actually less favourable. The converse is true of the minimum figure.

Similarly, the correlation between the chosen variables is set out in Figure 7. These correlations are based on historic correlations of the same variables suitably adjusted to reflect the valuer's view on how they might interrelate in the future.

	Rental Growth	Exit Yield	Holding Period	Equated Yield
Rental Growth		-0.50	+0.20	-0.30
Exit Yield	-0.50		+0.40	0.10
Holding Period	+0.20	+0.40		
Equated Yield	-0.30	0.10		

Figure 6: Correlations between the Chosen Variables

A perfect positive correlation will have a value of +1 and a perfect negative correlation will have a value of –1. A variable that is totally independent will have a correlation of 0. For example, the positive correlation at 0.40 between the holding period and the exit yield indicates that as the holding period increases, the age of the building at resale also increases making it lass attractive and thus the exit yield will correspondingly increase. As can be seen, *Crystal Ball* allows for multi-correlation between variables, which is a better representation of reality. These correlated inputs can be directly inputted into *Crystal Ball* as a most likely, best and worst and run for 10,000[8] simulations.

[8] We chose 10,000 iterations as it is sufficient to allow consistent results between different simulations

The Output Range

The Discounted Cash Flow valuation was run 10,000 times using the *Crystal Ball* simulation as detailed above. The outcome statistics[9] are listed in Figure 7 below.

Simulation	
Trials	10,000
Mean	£203,662
Median	£202,489
Standard Deviation	£9,068
Skewness	0.53
Kurtosis	3.08
Range Minimum	£182,013
Range Maximum	£227,369

Figure 7: Statistics from the Simulation

Here it can be seen that the expected mean (capital value) of £203,662 is not significantly different from the £200,000 produced by the discreet use of the implicit model. But the advantage of the Monte Carlo simulation is that provides additional information about the certainty of the result. In this case, the standard deviation (of £9,068) is a representation of the risk of the outcome not being the single point figure suggested. The skewness (of 0.53) represents the degree of asymmetry of the distribution around its mean. This number is relatively high and would suggest that there is a skew in the outputs to the right-hand side, which indicates that the upside risk (the likely hood of the outcome being higher than the mean) is greater than the downside risk. Obviously, this is a reflection of the variables chosen and the limits and correlations of each. Yet, this information remains hidden with conventional single point valuations. Another additional measure is the Kurtosis, which measures the peak/flatness of a distribution. A kurtosis of 3 suggests a normal distribution, anything above that number is peaked (leptokurtic) and anything less than 3 has a flat distribution (platykurtic), which tells us how the outcomes are concentrated around the mean. In this case, the kurtosis is only slightly above 3 and thus a normal distribution exists. This can also be represented graphically as illustrated in Figure 8 overleaf.

The importance of the statistics (whether shown numerically or graphically) is that it is placing the single point valuation in the context of uncertainty of inputs and the corresponding risk pertaining to the output. It is this that, we argue, increases the utility of the valuation (see on).

[9] Note that the statistics will differ very slightly each time the simulations are run. This is a result of the random nature of the selection of each variable. However, the variations are minimal and each simulation shows consistent relationships between the statistics.

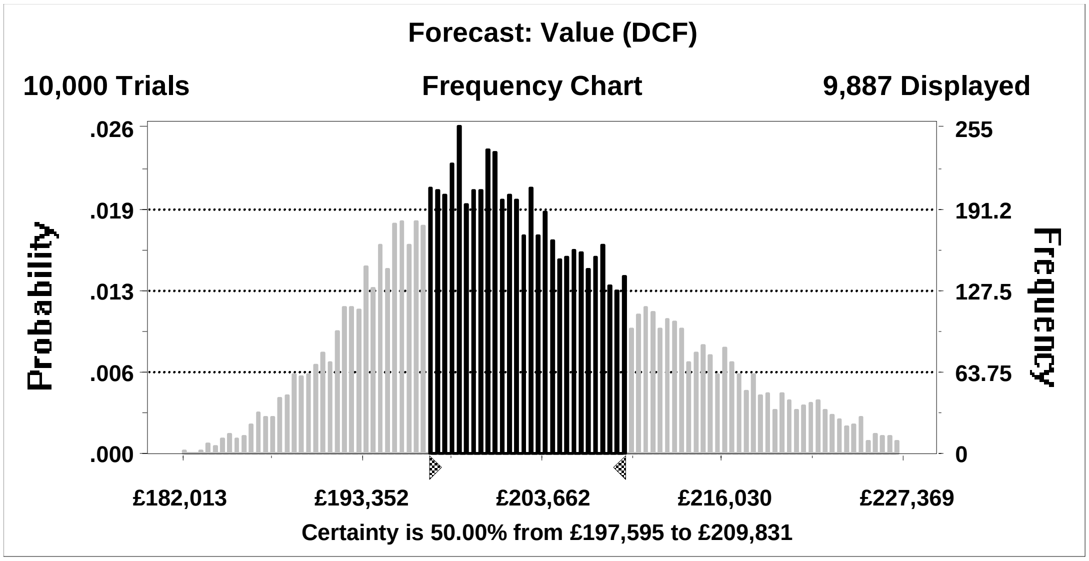

Figure 8: Output Distribution

In Figure 9 above, we can see a repeat of the numerical statistics above with a range of possible outcomes from a display[10] minimum of £182,013 and a maximum of £227,369 with a mean of £203,662. It can also be easily seen that there the distribution is skewed on the left with a long tail of outputs at the higher end of the graph.

An additional piece of information provided is the Certainty Range. Here the model allows the user to define a range of certainty of the outputs. This can be done in one of two ways. Either the valuer can ask for a level of certainly in percentage terms. In this case we have determined the higher and lower limits for a range with 50% certainty. This gives a range of £197,595 to £209,831 as displayed in black on the graph. Thus there is a 50% probability of the value lying between these figures. Alternatively, the valuer could set a range in monetary terms and test the level of certainty around predetermined limits of (say) £195,000 and £205,000. On this basis there is a 44% of the value being within this range (not shown graphically).

Placing Uncertainty in Context

In the above analysis, and the previous paper (French and Gabrielli, 2004), we have illustrated that it is possible to model the uncertainty pertaining to the information used to determine market value and to allow for this lack of

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[10] The Display range is between +/- 2.6 standard deviations, which includes 99% of the distribution.

certainty by asking the valuer to determine a three point range of possible inputs; the best, worst and most likely.

It is argued that the use of the triangular distribution, whilst not the most statistically robust, mirrors the thought process of the valuer and thus sits within their heuristic approach to valuation. By allowing for a range in the inputs, in either the All Risks Yield approach or the Discounted Cash Flow method, the valuer is openly acknowledging that there will always be a degree of uncertainty in the choice of input variables that must mean that the output figure, the valuation, is not a single figure.

This acknowledgement of the fact that the value of a property is not a single point is not a new concept. In other professions, most obviously the valuations of chattels and fine arts, the valuation is never given as a single figure but as a range (and often a very large range). Until an item is sold, the price is not determined. And as a valuation is simply an estimate of price (in advance of, or in the absence) of a sale, then the number provided can only ever be a best estimate. It is only the requirements of the user that has meant that property valuations have, over time, been accredited with a degree of precision that is not sustainable. The majority of valuations are not done in advance of a sale, but in the absence of the same. Valuations are carried out for collateral to underpin a commercial loan; to judge periodic performance; to determine asset value of a company etc. In each of these cases, a range of values would not serve the purpose of the user. They need a single point estimate.

The underlying premise of this paper, and indeed the professional reports that have prompted this research (see RICS, 1994 and RICS, 2002) is that the valuation figure should be placed in context and that the user would be better informed if the single point estimate provided was placed in context. By accepting that uncertainty exists, then a wise client may prefer to be informed about it, provided that it is reported in an organised and helpful way. A lender who is considering foreclosing on a loan may seek a valuation before deciding whether to embark upon this course. Any variability in the valuation figure may be of considerable importance in the decision. Equally, an investor or owner-occupier considering buying or selling may seek a valuation before embarking upon the effort or expense of the transaction. Again, an understanding of the valuer's uncertainties may give a key insight into the desirability of proceeding.

In other cases, there may be a resistance to the acknowledgement of uncertainty. Performance measurement of property relies upon the single point valuations at the beginning and end of the measurement period. Providing a client (or indexing provider) with information about uncertainty may actually be unhelpful, as it would openly question the robustness of the property's performance. Likewise, the reporting of uncertainty of value in a company account may appear contrary to the declared intent of such a document as a factual audited statement of the position of that company at a single snapshot in time.

Whilst accepting that there may be subsections of the market where the reporting of uncertainty may not be seen to be important, it can be argued that by failing to do so is abdicating the professional responsibility of the individual valuer and, more importantly, of the valuation profession. In the cases cited above where the reporting of uncertainty may question the apparent precision of the value, the end user is generally not the immediate client but investors who rely upon published public documents. The client may only be interested in the single figure, but others may intend to act upon the valuation, to buy or sell shares. They would be interested in the uncertainty of the value.

There is also a larger picture. Currently, valuers are asked to provide a single figure without any definitive and consistent guidance on if, and how, uncertainty should be reported. As a result, it is generally ignored. This reinforces the general perception of the users that property values are precise. In the last 30 years, there have been many court cases that have questioned the veracity of a valuer's valuation (see Crosby et al, 1998). In almost all of these cases, the perception was that a single figure should have been obtainable by all competent valuers within 10% of the "correct" figure[11]. Even though "obiter dicta" has suggested a small range is applicable, the overriding view is one of precision. The illusion of precision is a millstone for the valuation profession.

Valuers and the valuation profession are acting against their own interests by allowing this misconception to continue. The idea that a valuer can precisely estimate price in all instances is sophistry. We believe, instead, that the authority of the valuer is enhanced by the expression of uncertainty. If the valuer is seen to have considered a number of possibilities, to have used judgement in assessing each of them, but accepts fallibility within limits then the valuer is credible, and the client will benefit from that credibility. If the valuation profession is to defend and enhance its reputation then it should require its members to report uncertainty. The question remains as to the appropriate standard for conveying that information to the client.

[11] From the perspective of the Courts, judges commonly refer to the 'correct figure'. However this is misleading. They actually are referring to a figure somewhere within a range that a number of competent valuers would have reached. They will have no idea whether such a figure would, if tested by an actual sale at that point in time, would have proved 'correct'.

Reporting of Uncertainty

The premise of this paper is twofold. Firstly that the reporting of uncertainty is helpful to the client and, if consistently introduced, will enhance the reputation of the valuation profession. The second point is that a statistical analysis of inputs and the resulting outputs is an appropriate way of reporting uncertainty in valuations. It does this because it recognises that the estimate is a range and that forms a probability distribution. Previous work (Mallinson and French, 2000) argued that there were six items of information that should be conveyed when reporting uncertainty. These are:

1. The single figure valuation – Market Value (MV)
2. The range of the most likely observation (say, 5% either side of MV)
3. The probability of the most likely observation
4. The range of higher probability
5. The range of 100% probability
6. The skewness of probabilities

In this paper we suggest a slight modification to this set of information as follows:

1. The single figure valuation – Market Value (MV)
2. The Certainty range at 5%, 10%, 50% and 100%
3. The skewness of the distribution (reported as % at either end of range)

The reason for this modification is twofold. One, brevity; it is important that the concept of uncertainty is provided with the valuation, yet it should be done so with the least points of reference as possible. Two, clarity; the three reference points above capture all the items identified in the original items but, by using the certainty range, in a more succinct form. The advantage of the certainty range is that it is easy to present in a tabular form that is readily understood by all users. Most users are not comfortable with statistical references such as mean, variance and standard deviation and this short data set can convey these concepts in lay terms.

Thus in our example, the report to client would include the summary (as detailed in Figure 9), as the appropriate standard for identifying uncertainty. It should be noted, that the distinction between uncertainty and risk as discussed above may, through necessity, become blurred at this junction. In simple terms, we have identified that uncertainty affects the inputs and this results in the risk of the output not being the single point estimate. However, although the summary makes no mention of either concept but simply reports the specified ranges, it is reasonable to assume that the users will refer to this additional information as uncertainty. Although this may not be academically accurate, the benefit of conveying this information in an easily understood format, we believe, outweighs the need for semantic correctness.

Market Valuation				
Market Value (MV)	**£ 203,600**			
Certainty Range	**5%**	**10%**	**50%**	**100%**
	£202,489 to £204,865	£201,453 to £206,279	£197,595 to £209,831	£181,049 to £239,786
Skewness (Either side of 50% range)	Range above £209,831		Range below £197,595	
	52%		27%	

Figure 9: Reporting Uncertainty

The information on skewness indicates that it is more likely that the MV figure would be exceeded rather than undershot. The information on the certainty range provides an easy indication of upside and downside risk (albeit, it is accepted that this will be referred to as uncertainty) and most importantly the Market Value is still provided as a single point figure. This summary would be followed by some explanation. The degree of explanation would reflect the valuer's knowledge of the client and the purpose of the valuation. There is no reason why the report could not contain the full statistics for an 'informed' client, whilst a lay client would be better served by the base information in Figure 9.

Conclusion

The advantage of using an explicit Discounted Cash Flow model to analyse uncertainty is that it disaggregate the input variables and allows the valuer to question the inputs on an individual basis by expanding or contracting the range and varying the skewness according to market conditions and their professional judgement.

If it is believed that uncertainty should be conveyed to the users of valuations, then it is important that there is an agreed standard for the expression of the uncertainty of the inputs and agreement on the output information that must be conveyed with each valuation. There will always be debate about the appropriateness of the distribution chosen. However, for ease of use by the profession, we believe that the triangular approach is the most appropriate input standard and the certainty range the easiest form for reporting the outputs. The use of spreadsheets is now commonplace in the profession and the additional overlay of using a Monte Carlo model is easily accessible with existing statistical packages such as *Crystal Ball*. All valuations are uncertain and the explicit acknowledgement of this fact will help the profession to enhance the reputation and utility of valuation services.

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