PROPERTY CASH FLOW STUDIES: FOCUSING ON MODEL CONSISTENCY AND DATA ACCURACY

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Abstract:

The high degree of variability and inconsistency in cash flow study usage by property professionals demands improvement in knowledge and processes. Until recently limited research was being undertaken on the use of cash flow studies in property valuations but the growing acceptance of this approach for major investment valuations has resulted in renewed interest in this topic. Studies on valuation variations identify data accuracy, model consistency and bias as major concerns. In cash flow studies there are practical problems with the input data and the consistency of the models.

This study will refer to the recent literature and identify the major factors in model inconsistency and data selection. A detailed case study will be used to examine the effects of changes in structure and inputs. The key variable inputs will be identified and proposals developed to improve the selection process for these key variables. The variables will be selected with the aid of sensitivity studies and alternative ways of quantifying the key variables explained. The paper recommends, with reservations, the use of probability profiles of the variables and the incorporation of this data in simulation exercises. The use of Monte Carlo simulation is demonstrated and the factors influencing the structure of the probability distributions of the key variables are outline.

This study relates to ongoing research into functional performance of commercial property within an Australian Cooperative Research Centre.

Keywords: inconsistency, key variables, forecasting, sensitivity, simulation, probability distributions, value profiles.

INTRODUCTION:

The major corporate failures at the start of the twenty-first century have strongly highlighted the responsibility and accountability of asset managers. Governance is increasingly being measured by benchmarking against comparative assets. Property (Real Estate) assets fall within this category where the performance of the "responsible entity" will, in future, be more closely monitored by authorities and investors than in the past.

The evaluation of the underlying properties is a key performance measure for property portfolios and this monitoring is usually based on individual property valuations. Property portfolio asset managers have a strong interest in ensuring the accuracy of these valuations. Consequently, asset managers (and insurers) are carefully scrutinising the competency of valuers. Recently an asset manager requested probable valuers to identify their estimates of market forecasts as a basis for selection; this is a practice that will grow.

While accepting the difficulties of defining a single point estimate of value, market valuations of major investment properties are notoriously inconsistent. The variability in investment valuations is aggravated by the absence of clear standards and guidelines for valuers. The market demands that cash flow analysis is used for major property valuations but the approaches adopted by valuers are far from consistent. Many different models are used that are incapable of arriving at the same result even when the same inputs are used. This lack of uniformity signals a lack of professionalism to the client. There is an urgent need to address the problems of accuracy and variability in the use of cash flow models, especially for valuation purposes.

Research into the concepts and structure of cash flow models has not been popular over the past decade as it was considered too basic and unnecessary. Unfortunately the past research outcomes have not influenced the market place as there is substantial evidence of incompetent usage of cash flow studies today. Legal case history and public valuation documents provide continuous evidence of incompetent usage of the DCF approach. Consequently there is a real need to undertake empirical research that can provide a foundation for more informed usage of an essential valuation approach.

This paper will comment briefly on the current position regarding valuation uncertainty and model structure, before an in depth examination of ways to improve the accuracy of outputs from cash flow studies by focusing on the key input variables.

While cash flow models have been used for major property valuations for many decades, there is now a renewed and more intellectual approach to cash flow models that places greater emphasis on the accuracy of the input variables. The new, risk implicit, approach is referred to in the paper as the second generation of cash flow studies, as will be further explained later.

VALUATION INACCURACY

Many recent studies have examined and commented on valuation accuracy or variability (there is a literature review in Boyd and Irons, 2002). While it is acknowledged that valuation accuracy requires examination, the actual degree of inaccuracy is of less importance than consideration of ways of improving the accuracy of valuations. Brown et al (1998 expressed this sentiment in relation to the UK situation:

> Recommendation 34 of the Mallinson Report should not, therefore, be so concerned with valuation uncertainty. This is not the important issue. The focus should shift to identifying errors in valuations that might arise through the use of poor information or poor valuation practice. (p.12)

Gallimore (2002) also considered this point when examining the components of valuation inaccuracy. He came to the conclusion that three improvements were needed to address the degree of valuation accuracy. He listed these as:

(1) data improvement
(2) vigilance in monitoring for … external influence and bias, and
(3) consistency in the application of appraisal models. (p. 57)

The author believes that these are three major factors that require urgent attention to improve the quality of valuations. While the problems of external influence and bias relate to all valuations, the factors of data accuracy and model specification are highly relevant to cash flow exercises. In fact it would appear that valuers have greater difficulty with these two issues when using the cash flow approach than with the other valuation approaches. According this paper will specifically address:

(1) valuation model consistency (the removal of incorrect processes or formulae), and
(2) data accuracy (in particular the specification of uncertain input data)

It should be possible to remove the inconsistencies in the valuation cash flow models through a better understanding of the approach and this should be a priority for both academics and the professional associations. The second issue of forecasting expected values is a more difficult problem because of the predictive nature of the exercise but the use of relevant historical data and market simulation are essential components of the crucial inputs into the cash flow study.

SECOND GENERATION CASH FLOW MODELS

Before the days of hand held calculators the principles of discounted cash flow (DCF) studies were known and used. However, the early use of DCF exercises for valuation purposes, particularly in the 1960's and 1970's, was often highly criticised and lacked credibility, particularly in legal cases. The reason for the poor reputation was due largely to unprofessional use by valuers who did not fully understand the process and did not effectively communicate the nature of the exercise to the client. The user was more to blame than the approach itself.

The growing sophistication of the financial markets in the 1990's saw the revival of the analysis of cash flows using DCF exercises as a supplementary approach to the capitalisation approach. Today the cash flow approach is no longer a possible alternative but an essential approach for major property valuations; this does not infer that it is the only approach. This change has been brought about by the incorporation of property as a legitimate capital asset that must be measured using modern capital asset valuation approaches. This second generation of DCF studies focuses on risk analysis by identifying the accuracy of the input variables and, consequently, the resultant outputs. The emphasis is on simulating the most probable expected cash flow using market evidence. These cash flow models must form part of the toolbox of the professional valuer.

Many commercially marketed templates have been developed for property performance evaluation. Several of these software packages have been well received by property portfolio managers and, as a consequence, by many valuers. However these proprietary models are not without their problems (refer Parker and Robinson(2002), Drummond (2000)). Valuers may benefit from the use of proprietary models but they are acting irresponsibly if they are unaware of the model structure and the inherent assumptions used in the underlying model.

The question arises whether the emphasis on risk analysis and input variables will automatically result in more accurate studies? The simple response is no because there are still numerous inconsistencies in the models used in the marketplace and inadequate appreciation of the risk or variability inherent in the variables used in the models. In fact vast improvement is not only possible but essential in the understanding and application of cash flow studies in property valuation.

It is interesting to follow the attention that academics have given the DCF approach in their research and writings. Following numerous pioneering works in the 1960s and 1970s (including Downs (1966), Ratcliff (1972) and Dilmore (1971)) there was ongoing debate of the subject until the 1980s. About this time it was judged that research into DCFs was exhausted and therefore no longer part of mainstream research.

However over the past decade it was obvious that practitioners had not adequately comprehended the approach and demonstrated an inability to explain the approach in disputed cases. The transfer of knowledge from academics through their students to the market place has not been effective in informing the market. With hindsight, it is clear that the subject should have been given greater emphasis by academics in the 1980's and 1990's. The current refocusing on cash flow models is largely due to the pressure from asset managers who must quantify the level of risk of their property assets.

The new emphasis on the risk components and the variables can been be seen in the recent articles in both the Journal of Real Estate Finance and The Appraisal Journal. In particular the early works of Valachi (1978) and Zerbst (1980) on partitioning the IRR were resurrected by Brown (1998). This paper, together with several subsequent papers, emphasised the risk related to the assumptions in the DCF. Similarly recent articles in The Appraisal Journal show the renewed focus on current DCF research , such as:

> Willison, D., 1999, 'Towards a more reliable cashflow analysis'
> Parli, R., 2001, 'What's financial feasibility got to do with it?'
> Rabianski, J., 2002, 'Vacancy in market analysis and valuation'

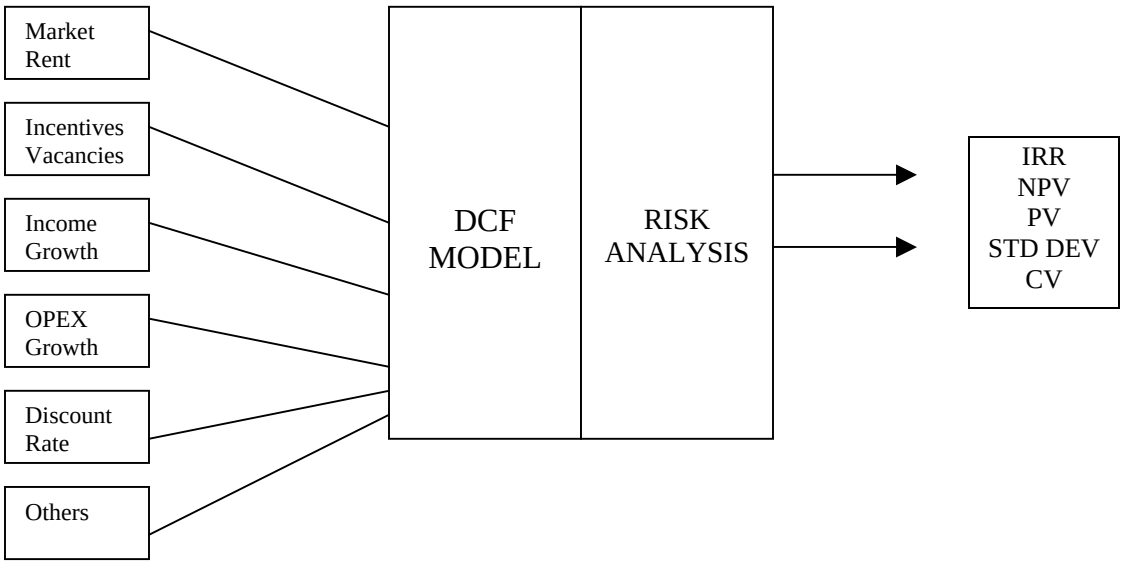
In the Journal of Real Estate Finance a tridium of papers by Wheaton et al (2001) was entitled, 'Real Estate Risk: A forward looking approach.' The authors stress that the uncertainty associated with the forecasting of market outcomes is the key measure of risk. While accepting the importance of market forecasts, the thesis of Wheaton et al has been challenged by Hendershott and Hendershott (2002). Without doubt this debate will continue. Another article in Real Estate Finance by Taylor and Rubin (2002) uses simulation to study the casual relationship of capital markets and property risk.

These articles and many others, such as French and Cooper (2000) in the United Kingdom, are returning attention to cash flow studies with specific reference to the uncertainty and forecasting ability of the studies. Thus the pendulum has swung again and both academics and practitioners are now giving serious consideration to the cash flow model structure and the input variables. This is encouraging as improving valuation accuracy should be a priority of the profession and academics.

CASH FLOW ANALYSIS PROCESS

While this paper will address the structuring of the key input variables in the cash flow analysis process, it is essential that the structure of the cash flow model is a sound platform for the analysis and simulates the process of the market players. The diagram below illustrates the components of the process (refer Exhibit 1).

Exhibit 1: Concept Map of DCF Performance Evaluation Approach



DCF models are notoriously different with many variations related to the time span, time intervals and structuring of the models. These differences will result in a spread of outputs and there is little guidance, if any, on what alternatives are more acceptable. Part of the problem is that practitioners use a variety of models and no clear industry standard exists that can be put up as the benchmark.

The effect of changes in both structure and variables of cash flow studies will be demonstrated with the aid of a case study. This case study, George House, is part of the DCF model development exercise being undertaken for the CRC CI project 11-5 (CRC CI, 2002). Refer to Annexures A and B of this paper for the Assumptions and Summarised Structure of this cash flow study.

In dealing with the key elements of the DCF model, the author will elaborate on:

1. the timing components
2. the terminal value calculation, and
3. effective rates of return.

These are discussed under separate headings below.

1. The Timing Components

DCF exercises must examine the future cash flows over a limited period of time (the duration) and allocate cash amounts to specific time periods. In fact there are three components of timing that must be taken into account in any DCF study. They are:

a) the duration of the study
b) the time intervals (rest periods) used, and,
c) the positioning of cash flows within the time intervals.

The **duration of the study** will change according to the expectation of the investment holding period. The difficulty of long term forecasting results in the recommendation that studies should not be extended to a long period of time; often considered to be in excess of ten years. On the other hand a cash flow study relies largely on the change of cash flows over a number of years to accurately reflect the change in the capital value of the asset. If a study period is too short, say 3 years or less, it may not show the probable longer term change in value. Hence it is important to select an appropriate time period and the author suggests that the standard duration should be between 5 and 10 years. The case study, George House, uses a time period of 7 years.

The **time intervals**, or rest periods, in a cash flow exercise are usually annual or monthly periods. Monthly intervals are more accurate than annual intervals because most properties receive regular income on a monthly basis. However studies with a longer duration are, at times, undertaken on an annual basis for simplicity sake. Other studies are undertaken with quarterly, half yearly or daily intervals. The use of daily intervals is the most precise approach but this degree of precision should only be used if a similar degree of precision is achievable in the selection of the input variables.

As an indication of the difference in resultant figures when monthly or annual studies are undertaken, the case study has been run in both modes, using both effective and approximate discount rates (i.e. annual divided by twelve) when monthly intervals are used. The resultant market values from the George House Case Study are shown in Exhibit 2 below:

Exhibit 2: Present Value Outputs with Different Time Intervals

	Annual Intervals	**Monthly Intervals with Effective Rates**	Monthly Intervals with Approx. Rate
Market Value	$ 92,904,327	**$91,245,144**	$ 89,172,042
%Age Deviation From Preferred Study	1.8%	**0 %**	-2.3%

It will be noted that the difference between an annual study and a monthly study using the effective equivalent discount rate is only 1.8 %. When the monthly study uses

approximate rates instead of effective rates the difference is -2.3%. The difference between the use of annual time intervals and monthly time intervals, **provided effective interest rates are used**, are relatively small. However, if approximate interest rates (simply dividing the annual rate by 12 to get the monthly rate), then the differential between annual and monthly studies is more substantial, in fact a differential of 4.0%. This demonstrates the importance of using effective, equivalent interest rates.

The positioning of the cash flows within the time intervals is an important element that is not given sufficient attention by many practitioners. Traditionally it has been a case of either selecting the 'in advance' or 'in arrears' option. Many practitioners have used the arrears option in annual studies, but this is not reasonable as it infers that no income or outgoings are received, or expended, until one year after the purchase date of a property.

More recently there has been an alternative of selecting the 'mid-point' of a time interval. This approach of bunching all income and outgoings into the middle of a time interval is a reasonable proxy for the actual situation. Other studies that work on a daily basis are not affected by the positioning within the time interval.

The positioning of the cash flows has a substantial effect when **annual** time intervals are used. The effects were tested in the George House case study and the results are shown in Exhibit 3 below:

Exhibit 3: Present Value Outputs: Alternative positioning of cash flows within time intervals

	Annual Beginning period	Annual Mid-Period	Annual End Period	**Monthly Beginning Period**	Monthly Mid-Period	Monthly End Period
Market Value	$92,904327	$88,681403	$84,458479	**$91,245144**	$90,884221	$90,523298
% Age Change	1.8 %	-2.8 %	-7.4 %	**0 %**	-0.4 %	-0.8 %

The table shows that there are big differences between beginning and end period studies when **annual** intervals are used but insignificant differences if monthly intervals are used. The difference between the resultant values using beginning and end period calculations for annual studies is 9.1% in this case study. While the positioning of the terminal value will influence this differential, it should be noted that very different market values will result if one person uses a beginning period, annual study and another person uses an end period, annual study. The author considers that end period, annual studies are inaccurate representations of market value as they unrealistically depress the value. As a final note it is important to adjust the NPV formula in computer-based spreadsheet programs if a beginning or mid-period calculation is required.

2. Terminal Value Calculation

The cash flow model must make allowance for the residual value of the asset at the time of termination of the study. This terminal value should represent the most probable selling price of the asset at that time; assuming there is a residual value. The usual question to consider is "what will the next purchaser expect to pay at that time?" For investment properties, the projected income for the year after the termination date should form the basis for the value. Increasingly, this point is being accepted by the market.

The other factor in the calculation of the terminal value is the terminal capitalisation rate. This capitalisation rate should relate to the initial capitalisation rate from the property but the initial rate may be increased because of increased age and poorer condition of the building. On the other hand the initial rate could be decreased if the building has been upgraded or a more favourable market scenario is expected at the time of termination.

Consideration should also be given to where, in the time interval, the sale is deemed to occur. If the beginning period allocation is used then the sale should be assumed at the beginning period and visa versa. Provided logical thought processes are used the calculation of the terminal value should be consistent across all studies. However historic net income should not be used to determine the terminal value, nor should it be assumed that the terminal capitalisation rate must be higher than the initial capitalisation rate.

3. Effective Equivalent Rates

When time intervals used in a DCF exercise are not annual, then the interest and discount rates should represent the effective equivalent rates for the chosen time interval. Most interest rates and discount rates are quoted in annual percentage terms and it is desirable to make comparisons and identify the selected rate as an annual rate. The effective rate formula is given in most textbooks and should be used in all non-annual studies. Exhibit 2 showed the difference between effective and approximate conversions of the discount rate from an annual rate to a monthly rate; this difference is significant.

Three important elements of the DCF model structure have been briefly described above. Provided the most logical market simulation interpretation is used, a consistent resultant figure is achievable. There should be an industry standard that specifies the recommended approach for the structural components of a DCF model that are referred to above. It is unfortunate that the International Valuation Standards (IVSC 2001) are not more specific on these points, as it could improve model consistency.

KEY VARIABLE SELECTION

A cash flow study requires numerous inputs, some of which are known but many are uncertain and require the judgement of the expert to ensure a realistic output. The well-repeated phrase "garbage in, garbage out" is highly applicable here.

To improve the accuracy of the output it is necessary to identify those uncertain inputs that have a substantial affect on the resultant output. It is logical to place the emphasis on these key variables so that attention can be given to their selection; this will assist directly in risk minimisation.

The uncertain variables should be identified in the assumption and rent/income schedule files of the cash flow study (refer to Annexure A). These typically include variables related to:

- the cost of the asset (including transfer costs)
- current and market rent levels
- rental growth over time
- incentives and vacancy allowances
- current operating expenses
- operating expense growth over time
- expected capital expenditure over time
- terminal value components (eg. terminal yield, costs)
- the discount rate
- and others, if external finance and/or taxation issues are considered.

Numerous researchers, including the author, have tested the sensitivity of these variables on the resultant output (Taylor and Rubin (2002), Wheaton et al (2001), Hendershott and Hendershott (2002), Willison (1999)). Hutchinson and Nanthakumaran (2000, p.43) suggest that the key variables in their study were:

- passing rent
- rental growth rate
- holding period
- exit (terminal) yield
- discount rate

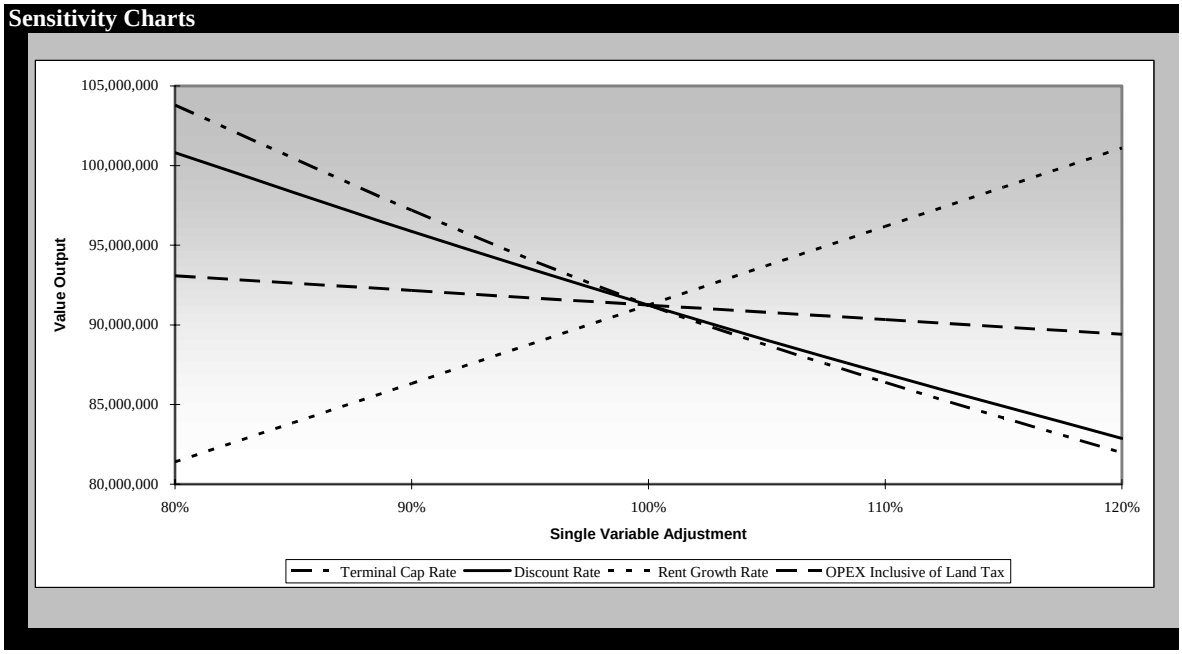
While the duration and characteristics of a particular study will cause the relative sensitivity of the variables to change, the importance of several key variables is common to most studies.

The key variables usually include **the rental growth over time, the discount rate and the terminal value**. Factors such as operating expense escalation and transfer costs have a minor influence on the resultant figure and, consequently, less attention need be given to these inputs. The initial purchase price and loan finance interest rates, if included in the exercise, may also have a strong influence on the output figures. Other variables, such as rent incentives and capital expenditure, may also prove highly sensitive in certain cases.

The sensitivity of the key variables is often measured using a sensitivity (spider) diagram which measures the output change for a realistic change in that variable only. The drawback of this analysis is that only one variable can be changed while the others are held static. This is not a realistic situation as some correlation exists between many of the variables, but it is acceptable for identifying the more sensitive variables.

An illustration of a sensitivity (spider) diagram is shown in Exhibit 4 below. This shows the variation of several variables used in the George House Case Study. It should be noted that the gradient of the discount rate, terminal capitalisation rate and the rental growth rates are steep, demonstrating their substantial impact on the resultant figure. The operating expense growth rate is not highly sensitive.

Exhibit 4: George House Sensitivity Study –Effect of single variable change



Another measure of the sensitivity of individual variables is the examination of the output change for a realistic change in an input variable. The illustration of this measurement, as calculated in the Crystal Ball application of George House, is the rank correlation as shown in Exhibit 5 below:

Exhibit 5: George House Market Value Estimates: Sensitivity of Variables

Variable	Rank Correlation
Discount rate	-0.66
Terminal capital rate	-0.71
Rent growth rate	0.30
Open growth rate	-0.07

Calculation of George House using Crystal Ball

Both exercises demonstrate that the terminal cap. rate, the discount rate and the rental growth rates are the most sensitive variables and, accordingly, should be very carefully selected. The risk of variability in the resultant value is largely dependent upon the

accurate estimation of these three variables. It should be noted that this basic exercise is not levered so the effect of changes in interest rates has not been examined.

KEY VARIABLE PROFILING

In most cash flow studies the key input variables are included as single point estimates but this approach does not take account of the uncertainty of these estimates. In order to incorporate a measure of reliability of the resultant figure, it is highly desirable to consider and quantify the probable range of values of the key variables.

One approach is to use scenario studies which look at the worst case, best case and most likely case results. This approach determines defensible maximum, minimum and most likely figures for each variable. The limitations of this approach are that, firstly, only three values are considered (two of which are extreme values) and, secondly, when incorporated in a scenario study, the extreme values are linked to extreme values of the other variables resulting in highly leveraged, extreme situations. These studies should consider the covariances between the key variables as a means of reducing the extreme values. Within the scenario approach it is desirable to apply probabilities to the best, worst and most likely situations because this will minimise the effects of the extreme values.

Another way of identifying the probable range is to use a probability distribution for each variable. While this approach requires the selection of a specific value profile of each variable, it has the advantage of specifying not only the possible range but also the probability of values within the range. The specification of probability distributions infers that multiple runs are necessary to provide a broad cross-section of probabilities. This is not a problem as simulation exercises, such as Monte Carlo Simulation, have been used for many decades to run probability exercises and there are several software programs that can assist with this exercise.

DETERMINING KEY VARIABLE VALUES IN SIMULATION EXERCISES

Simulation exercises have the distinct advantage of incorporating probability distributions for the key variables. However the accuracy and reliability of the output is severely limited by the quality of the input data and the random selection process used in the exercise. Selecting the profile of the probable values of key input variables is assisted by the range of distribution profiles provided in the simulation packages. Crystal Ball, a registered trademark of Decisoneering Inc and @ Risk, a registered trademark of Palisade Corp., are two similar products that provide a choice of distribution profiles within the simulation program.

In determining the probability distribution of the key input variables, the user must not only select the most approximate profile but also the key values for that particular distribution. This is the crucial role of the professional and it requires a sound understanding of the causal influences on that variable as well as the correlation between key variables. Market analysis is essential to define the values of the key variables.

Fortunately the secondary market data availability, particularly at the macro level, is increasing and this information supports the difficult task of defining the profiles of the key variables.

The case study, George House, relates to a property in Brisbane, Australia and it is important to collate the macro-economic data and forecasts for this region over the future period of the study. Several market analyst reports are available that forecast economic indicators and these forecasts serve as useful guides to expected economic activity that will influence growth and discount rates. An indication of the current expectations of economic data for Queensland, prepared by Access Economics, is shown in the table (Exhibit 6) below.

Exhibit 6: Queensland Forecasted Economic Data

Queensland: Forecasted Output and Demand						
	Percentage Change					
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Gross State Product	5.3	4.2	3.8	3.7	2.3	4.4
Real Final Demand	5.8	5.3	3.2	3.1	3.8	5.8
Private Consumption	4.4	4.9	3.8	4.3	2.0	4.5
Private Housing Investment	28.0	-1.1	-5.1	-0.7	22.2	23.8
Private Construction Investment	-1.2	18.6	13.4	7.5	8.9	11.1
Industrial Production	4.5	1.8	13.0	7.3	1.7	6.6
Retail Turnover	3.3	4.8	2.1	4.2	1.8	3.6
Total Population	1.9	1.7	1.6	1.6	1.5	1.5
Employment Rate	2.2	2.2	2.1	1.9	0.8	2.0
Unemployment Rate	7.9	7.1	6.5	6.5	7.4	6.9
Consumer Price Index	2.9	3.0	2.1	3.3	2.4	1.4

Source: Access Economics, Sept 2002

This Table represents a forecast of one analyst and should be compared to the opinions provided by other sources such as Macquarie Research, ANZ and the Centre of Policy Studies. Historical property data is available from analysts that specialise in this sector, including Property Council of Australia, BIS Schrapnel and numerous Real Estate Groups. However, only short term projections, if any, are provided by the property market analysts.

The property professional should source as much relevant secondary data as possible and thereafter make a reasoned subjective judgement on the probability distributions of the key variables. While accepting that the forecasts will not be accurate, the discipline of profiling the key variables enhances a reasoned approach because probable causal factors are explicitly considered.

CASE STUDY SIMULATION EXERCISE

The author has structured a probability profile for each key variable in the George House study and is currently analysing market data to test the relationship to the selected profile. In determining the initial profiles, the following factors were taken into account:

1. Discount Rate
    - current 10 year bond rate in Australia
    - expected changes in long term bond rates
    - current market yields of relevant office sectors
    - current targeted returns (IRRs) from sales of office buildings
    - current yields of the Listed Property Unit Trusts (Office sector)
    - comparative coefficient of variation of expected net income
    - consumer price index change

2. Terminal Yield Rate
    - initial yield rate of subject property
    - capital expenditure allowance in study
    - economic indicators for year of sale
    - lease profile at time of sale
    - Brisbane office supply and demand trends

3. Rental Income Growth Rates
    - Current lease conditions
    - State and national economic indicators
    - Brisbane office supply and demand trends
    - Industry sector demographics and growth expectations
    - Current level of incentives
    - Consumer price index change

Preliminary studies have not shown a consistent relationship between the key variables and the selected economic factors over time, however this research is continuing. The CRC project 11-5 team is attempting to construct ex-ante property prediction bands for particular property types, gradings and locations. These bands may be useful indicators for the estimation of the key variables.

The author has chosen the distribution profiles after examining historical market data, other research and current ranges of rates of return. He has selected a slightly skewed triangular distribution for the discount rate, a lognormal distribution rate for the internal capitalization rate and a normal distribution for the rent escalation rates. It is acknowledged that this selection is subjective and more research is necessary to justify the selection of distribution profiles (refer also McAlister,2001,p.371).

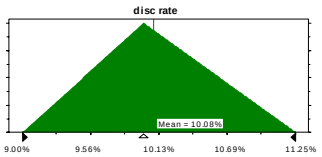
The initial profiles and values for the key variables in the George House case study are shown in Exhibit 7 below:

Exhibit 7 : Key variable Probability Distributions: George House

Assumption: Discount rate

Triangular distribution with parameters:

Minimum	9.00%
Likeliest	10.00%
Maximum	11.25%

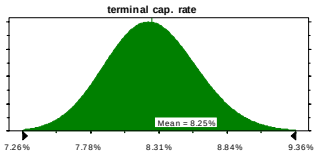


Selected range is from 9.00% to 11.25%

Assumption: Terminal cap. rate

Lognormal distribution with parameters:

Mean	8.25%
Standard Dev.	0.35%

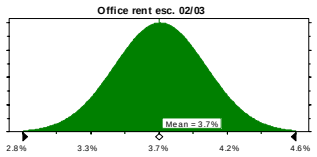


Selected range is from 0.00% to +Infinity

Assumption: Rent esc. 02/03

Normal distribution with parameters:

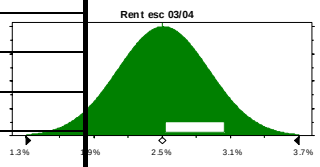
Mean	3.7%
Standard Dev.	0.3%

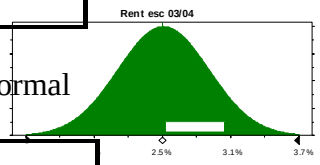


Selected range is from -Infinity to +Infinity

Thereafter, all rental escalations have a normal distribution but the defining statistics are:

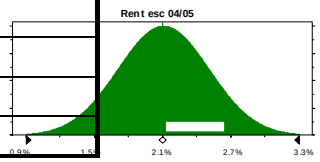
	Mean	Standard Dev.
03/04	2.5%	0.4%
04/05	2.1%	0.4%
05/06	2.7%	0.5%
06/07	1.8%	0.5%
07/08	5.8%	0.6%
08/09	4.7%	0.7%
09/10	3.5%	0.8%





Another assumption was Operating Expenses, which was selected as a normal distribution and the following figures:

	Mean	Standard Dev.
02/03	2.9%	0.2%
03/04	2.1%	0.3%
04/05	3.3%	0.3%
05/06	2.4%	0.4%
06/07	1.5%	0.4%
07/08	1.6%	0.5%



08/09	2.3%	0.5%
09/10	2.5%	0.6%

THE OUTPUT

The key variable profiles were run in a Monte Carlo simulation exercise. While accepting the limitations of the random sampling process used in a simulation exercise, it is the author's experience is that the exercises should run thousands of trials (ie calculations of the resultant value) in order to ensure adequate coverage of the probabilities; his recommendation is, at least, 5000 trials. The result of the trials is a probability diagram and related statistics. The diagram for the profiles shown in Exhibit 8 as part of the George House study is shown below:

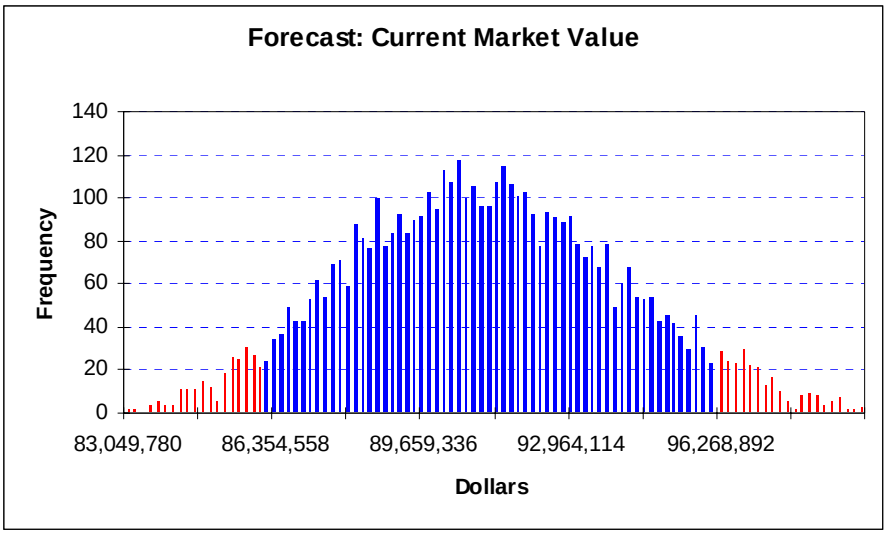
Exhibit 8: George House Crystal Ball Output Results

Forecast: Current Market Value

Summary:

Certainty Level is 90.00%
Certainty Range is from 86,180,216 to 96,148,878 Dollars
Display Range is from 82,967,161 to 99,491,050 Dollars
Entire Range is from 79,802,099 to 104,236,632 Dollars
After 5,000 Trials, the Std. Error of the Mean is 43,666

Statistics for Display Range:	Value
Trials	4963
Mean	91,031,247
Median	90,973,162
Mode	---
Standard Deviation	2,993,516
Variance	9E+12
Skewness	0.10
Kurtosis	2.63
Coeff. of Variability	0.03
Range Minimum	82,967,161
Range Maximum	99,491,050
Range Width	16,523,889
Mean Std. Error	42,492.23



These statistics refer to all possible solutions using the range of variables selected. In interpreting the figures the author relies on the mean figure as the most probable value and determines a range based on the 90% certainty limits. The reason for this selection is to exclude the extreme values and provide a reasonable yet inclusive range. This selection of the 90% cutoff is a subjective decision.

Using the simulation results, the market value estimate may be described as:

> **"The most probable market value of George House as at (date) is $91 million and the estimated range of market values is from $86 million to $96 million."**

This identification of the most probable value and a range of values gives the client a measure of risk in the estimation of value. It translates the uncertainty in the key input variables into the final figures. Other measures of accuracy are available from the related statistical figures in Exhibit 8.

A comment by McAlister (2001,p.373) sums up the appropriateness of simulation;

> The major benefit of simulation methodology is that uncertainty in the key variables is recognized and incorporated in the pricing process. Such methods offer rational, although not comprehensive, solutions . . . the major benefit is that explicit and transparent analysis is permitted.

CONCLUSIONS

This paper addresses the need to provide practical proposals for the improvement of understanding and application of cash flow studies for property investment analysis. Researchers have identified model consistency and input data as two major areas of concern in the application of DCF studies and this study deals with both these issues.

Emphasis is placed on the selection and quantification of the key input variables in the studies. These variables include the discount rate, the terminal capital rate and the rental

growth rate. In order to assess the certainty of the output it is necessary to determine a range or profile for these key variables. The study recommends that profiling the probability distribution of these variables is the more accurate way of defining these variables.

It is not an easy task to select the probability profile of the variables and the paper refers to the current research being undertaken to examine the effect of macro and micro economic and property indicators on the profile of these variables. A case study is used throughout the paper to demonstrate the main elements of model inconsistency and the quantification of the key input variables. The outputs from the case study are a valuation figure and a range of values that relates directly to the uncertainty inherent in the key input variables of the exercise.

As this research is ongoing, the author is keen to receive comment on the topic. In particular the CRC CI team on project 11-5 would welcome feedback from persons who have tested simulation studies of market-based property cash flows.

October 2002

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Assumptions Sheet — George House

For the Discounted Cash Flow Analysis of: George House — Date: 1-Aug-02

KEY ASSUMPTIONS			
Holding Period	7 years	Assessment Intervals	Monthly
Discount Rate	10.00%	*Effective Monthly Discount Rate*	0.797%
Discount Rate Incorporating Debt Financing	11.00%	*Effective Monthly Discount Rate*	0.873%
Terminal Cap Rate	8.25%		
Purchase Costs	4.00%	Sale Costs	1.50%
FINANCING			
Purchase Price (output from TC study)	$91,000,000		
Amount of Market Value Assessment	60%		
Fixed Interest Rate	7.50%	*Effective Monthly Interest Rate*	0.60%
Term	25 years		
Loan Establishment Fee	0.50%		
Redemption Charges	0.10%		

Escalation Table

Escalations for year ending	31 Jul 03	31 Jul 04	31 Jul 05	31 Jul 06	31 Jul 07	31 Jul 08	31 Jul 09	31 Jul 10
CPI Escalation	2.9%	2.1%	3.3%	2.4%	1.5%	1.6%	2.3%	2.5%
Office Rental Escalation	3.7%	2.5%	2.1%	2.7%	1.8%	5.8%	4.7%	3.5%
Retail Rental Escalation	3.7%	2.5%	2.1%	2.7%	1.8%	5.8%	4.7%	3.5%
Other Income Escalation	3.7%	2.5%	2.1%	2.7%	1.8%	5.8%	4.7%	3.5%
Car Park Rental Escalation	3.7%	2.5%	2.1%	2.7%	1.8%	5.8%	4.7%	3.5%
OPEX Escalation	2.9%	2.1%	3.3%	2.4%	1.5%	1.6%	2.3%	2.5%

Allowance Table

Allowance for year ending	31 Jul 03	31 Jul 04	31 Jul 05	31 Jul 06	31 Jul 07	31 Jul 08	31 Jul 09	31 Jul 10
Bad Debt and Vacancy	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%

Incentives and Letting Up

Type	Term (years)	Review Type	New Lease Letting Up	New Lease Cost	Cost (mths equiv)	Existing Tenant Letting Up	Existing Tenant Cost	Cost (mths equiv)
Retail	5	Annual Market	6 months	2 mths commision plus 20% incentive	8 months	3 months	1 mth commision plus 10% incentive	4 months
Office	5	Annual Market	9 months	2 mths commision plus 30% incentive	11 months	5 months	1 mth commision plus 15% incentive	5.5 months

Total Capital Discounted Cash Flow Analysis — George Street

Monthly cash flow forecast for the 7 year period 1 Aug 2002 to 30 Sep 2009

Key Assumptions	
Holding Period	7 years
Assessment Intervals	Monthly
Discount Rate	10.00%
Effective Monthly Discount Rate	0.797%
Terminal Cap Rate	8.25%

Results			
ESTIMATED PRESENT VALUE	10.0% discount rate		94,894,949
Less Purchase Costs		-	3,649,806
ESTIMATED CURRENT MARKET VALUE			91,245,144
MARKET VALUE Purchase Price	***Say***	**$**	**91,000,000**

Annual Term Commencing	01-Aug-02	01-Aug-03	01-Aug-04	01-Aug-05	01-Aug-06	01-Aug-07	01-Aug-08	01-Aug-09
Period	0	1	2	3	4	5	6	7
GROSS INCOME								
Retail Rental Income	628,935	645,276	671,348	690,100	687,902	703,514	589,221	774,451
Commercial Rental Income	7,827,231	8,034,953	8,308,094	8,580,774	8,710,849	8,773,466	8,544,243	9,788,680
Car Park Rental Income	671,675	691,825	712,580	733,957	756,290	782,760	810,157	838,513
Naming Right Income	50,000	50,000	50,000	50,000	50,188	50,750	50,750	50,750
Other Rental Income	200,861	206,165	213,005	218,024	223,070	230,117	240,932	251,875
					-	-	-	-
Total Gross Income	**9,378,702**	**9,628,219**	**9,955,027**	**10,272,855**	**10,428,299**	**10,540,607**	**10,235,303**	**11,704,268**
EXPENSES								
OPEX Inclusive of Land Tax	- 1,744,840	- 1,789,001	- 1,836,425	- 1,889,396	- 1,926,902	- 1,956,690	- 1,994,285	- 2,041,989
Bad Debt and Vacancy Allowance	- 4,677	- 4,801	- 4,964	- 5,122	- 5,200	- 5,256	- 5,104	- 5,836
Incentives and Agents Commission	-	- 1,161,837	-	-	-	- 397,512	- 464,753	- 579,802
					-	-	-	-
Net Income	**7,629,185**	**6,672,581**	**8,113,637**	**8,378,337**	**8,496,198**	**8,181,148**	**7,771,160**	**9,076,642**
CAPITAL EXPENDITURE								
Projected Refurbishment	-	- 200,000	-	-	-	- 700,000	- 600,000	-
					-	-	-	-
NET TERMINAL VALUE								
Sale Price (year 6 NOI/terminal cap rate)	-	-	-	-	-	-	-	110,019,900
Less Sale Costs	-	-	-	-	-	-	-	- 1,650,299
NET CASH FLOW	**$ 7,629,185**	**$ 6,472,581**	**$ 8,113,637**	**$ 8,378,337**	**$ 8,496,198**	**$ 7,481,148**	**$ 7,171,160**	**$ 108,369,602**
Running Yield on Purchase Price	8.4%	7.3%	8.9%	9.2%	9.3%	9.0%	8.5%	10.0%