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A discussion of the Monte Carlo technique applied to commercial property: Examining risk in perspective

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A DISCUSSION OF THE MONTE CARLO TECHNIQUE APPLIED TO COMMERCIAL PROPERTY

– Examining Risk in Perspective

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This paper discusses the application of the Monte Carlo simulation technique to commercial property investment feasibility studies. The paper is divided into five sections as follows:

1. A discussion on the variables in commercial property returns
2. A critique of commonly used contemporary techniques for project feasibility analysis
3. An overview of the Monte Carlo risk analysis technique
4. Interpretation and analysis of simulation results
5. Utility, and inherent limitations, associated with modelling real world uncertainty using Monte Carlo

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VARIABLES IN PROPERTY RETURNS

Commercial property is a capital intensive and illiquid asset class that requires periodic capital investment in order to maintain and enhance its status, occupancy and yield. Capital is typically called for to address issues arising from technical obsolescence, physical deterioration, compliance with codes and standards and aesthetic presentation; these are all challenges to, and characteristics of, real property. Some studies have estimated that over a building's lifetime, three to four times the initial construction cost will be spent again on physical upgrade works. It follows that the assessment of the risks and benefits associated with major capital expenditure is a significant and continuing task for investors and managers in commercial property.

When evaluating any capital investment project, assumptions must be made concerning a multitude of future variables. In an investment property these typically include the rent and rental growth that is likely to be achieved following refurbishment or construction, along with any incentives that will be required in order to induce tenants to pay that rent. Additionally, future lease commencement date(s) following any periods of vacancy must be assessed, together with the prospective cost and completion date of construction activities. Once these assessments are made, they can be factored into a feasibility model that provides a net present value and internal rate of return, of the predicted future income and expense streams. The net present value is conditional on the selection of a discount rate that reflects the project's assessed risk profile and internal rate of return hurdle, reflective of the organisation's assessment of project risk.

The risks associated with capital expenditure in commercial property are ubiquitous and multifarious and include both systemic and unsystemic factors. For example, the market's demand for office space is a cyclical variable to which market rents, incentives and vacancy periods demonstrate elasticity. That is, when the demand for commercial office space wanes, the rent that landlords can expect to receive for vacant space experiences downward pressure, while the incentives that must be paid to incoming tenants tend to increase. The opposite is true in markets where supply is scarce and demand is strong. Similarly, the exogenous risk posed by the introduction or withdrawal of competing property stock into the market impacts market supply characteristics and therefore project viability. Equally, property construction itself is subject to market prices, material and labour availability, the quality of the construction team's contractor management, design information, knowledge of site conditions (including latent conditions) and contract documentation. Finally, when a project is completed and tenants have been secured and are paying rent, the capitalisation of net income approach to property valuation is subject to the capricious capitalisation rate.

It is therefore incongruous that, while the outcomes of capital investment decisions are uncertain, traditional feasibility outcomes are frequently presented as single values with no margin of error or deviation from one number.

As an alternative to single value assessments, this paper discusses a model for project investment appraisal that acknowledges the inherent variability in feasibility inputs and their concomitant effects on likely project outcomes. The correct evaluation of project risk requires an understanding of the characteristics of uncertainty that surround a given risk variable and an ability to meaningfully process its implications to a project's return.

The benefits of this approach to feasibility analysis are:

- A broader understanding of project risks,
- An understanding of the effect that a risk event, or multiple risk events will have on project outcomes,
- An understanding of the probability of a risk event occurring,
- A tool for the meaningful comparison between competing projects,
- More fully informed investment decisions, and
- An opportunity for collaboration between project sponsors, consultants, experts and decision makers.

CONTEMPORARY TECHNIQUES FOR PROJECT RISK ASSESSMENT

Property is a wasting asset whose utility becomes depleted over time. For example, plant and equipment ages and deteriorates with use, and the codes and standards to which a property is constructed change to reflect contemporary requirements, such as the Disability Discrimination Act and the Building Code of Australia. Additionally, user expectations evolve to require innovative features from property such as sustainable attributes arising from either government legislation, community expectation or the need to remain competitive with newly built product entering the market.

In these circumstances, capital expenditure is regularly required to maintain a property's relevance and yield. The ongoing requirement for capital requires managers to regularly assess the optimal scope and cost of capital improvements with regard to the expected future cash flows following such investment.

Conventionally, the assessment of investment opportunities utilises a discounted cashflow (DCF) approach over an investment horizon, by reference to future variables. Examples are lease commencement dates, expected rents, rental growth rates, initial and ongoing capital requirements and terminal value along with acquisition and disposal costs. The net present value (NPV) of future cash flows is then determined by an appropriate discount rate, or target internal rate of return (IRR), to arrive at a present value of the investment. The formula for deriving NPV is shown below:

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$$

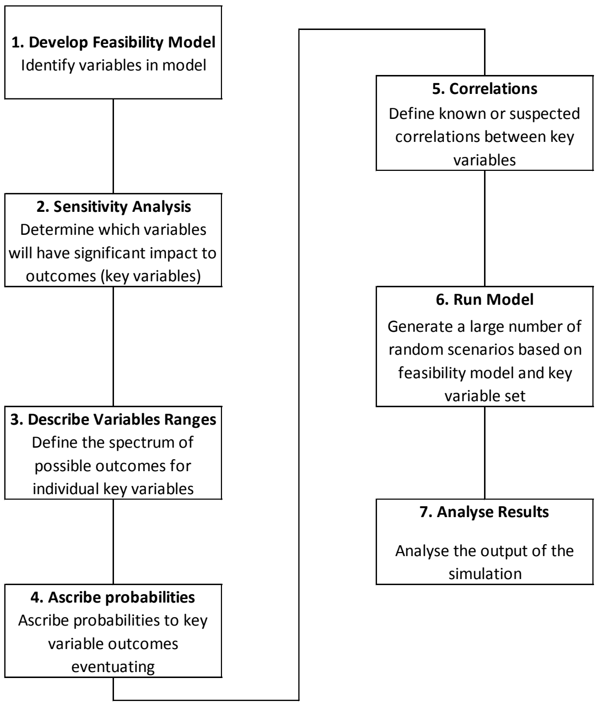
C is the net value of the cash flow amount in a future period

r is the discount rate, which reflects the cost of capital, inflation and project specific risk

N is the time before the future cash flow occurs

An estimation of future variable values may include either conservative estimates, modal (most likely to occur) estimates or estimates based on expert opinion. Whatever future value estimates are selected, the NPV is frequently presented as a definite number without margin of error.

In acknowledgement of the fact that the forecast outcome is in fact uncertain, a feasibility report normally includes a sensitivity analysis whereby one or more project variables are modified in order to ascertain the impact on the project's outcome. The selection of the variable(s) for the sensitivity analysis, and the range of possible variable values considered, is often arbitrary with no probability ascribed to any particular outcome occurring.



Going a stage further, scenario analysis reviews the effects of simultaneous changes to a number of project variables, thereby anticipating a range of alternative outcomes to the project. Best case and worse case outcomes are normally presented as part of a feasibility report.

Sensitivity and scenario analyses address some of the shortcomings of single value deterministic appraisal by allowing decision makers to envisage alternative project outcomes. These tests however, are essentially immobile and subjective and do not provide reviewers with a sense of how likely one outcome will occur over any other outcome.

MONTE CARLO

Stochastic analysis, based on the Monte Carlo simulation technique, introduces an additional dimension to risk analysis by bringing objectivity and dynamism to project evaluation making it a logical extension to sensitivity and scenario analyses. Monte Carlo utilises a project's key risk variables to build up a large number of random scenarios in order to provide a comprehensive probability distribution of the expected risk and return profile for a given project. Monte Carlo augments traditional investment appraisal by providing a full array of investment outcomes and expands the probability of those outcomes eventuating over the single value number that is provided by deterministic appraisal.

Importantly, the simulation must be managed so that model does not infringe any known or suspected correlations between variables. For example, it is likely that a protracted construction period will also result in additional construction costs and this positive correlation should be factored into the model.

Quantitative research should be used to describe variables where it is available and practicable - for example research into the mean and standard deviation in capital expenditure, rent, incentives and periods of vacancy for budgeted versus actual outcomes[1] in investment property can be used where appropriate to predict the likely future performance of these variables. In addition, expert opinion can be sought to assist with quantitatively describing the uncertainty surrounding the key risk variables to the project's forecast return.

DEVELOPING A FEASIBILITY MODEL

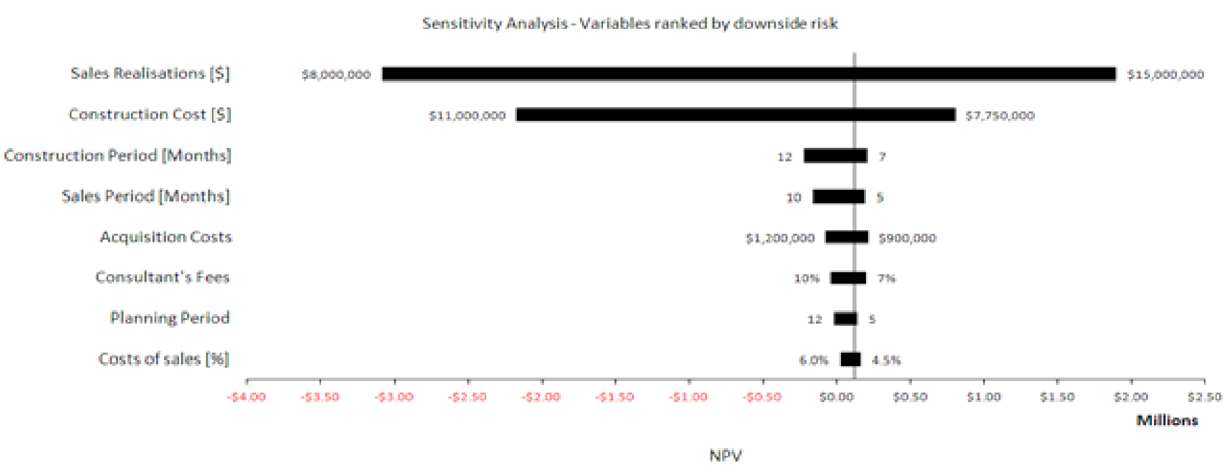
Property returns are typically forecast using a discounted cashflow over the theoretical investment horizon or a development project specific cashflow model. The model defines the mathematical relationships between the input variables which operate together to produce the expected outcome. Proprietary property systems are available, often with a Microsoft Excel overlay which then allows for the introduction of Microsoft Excel compatible "off the shelf" Monte Carlo software packages.

SENSITIVITY ANALYSIS

Following the development of the feasibility model, sensitivity analysis can be conducted on all of the risk variables in order to determine which variables are key. A key risk variable is one where minor variations in it have the capacity to affect the viability of the project. An example of ranked sensitivity analysis is shown below.

The arbitrary nature of sensitivity analysis means that input variables could be modified by ± 5 or ± 10 per cent (or some other value) without reference to how realistic or otherwise that change in the project variable is likely to be.

SAMPLE SENSITIVITY CHART RANKED FOR DOWNSIDE RISK



[1] The author has conducted research into these variables (not the subject of this paper).

Sensitivity analysis can be made more relevant by reference to the probabilities of a given event occurring. For example, in a commercial property investment, a comparatively minor variation in the rental that is received for a completed building can have a significant impact on project returns. However, if an enforceable pre-lease is in place, to a quality covenant tenant, the risk of this event occurring is very low. On the other hand, if a variable has a high degree of uncertainty but is not significant to the project returns over the investment period, then this variable should not be included in stochastic analysis. An example is the one-off legal costs associated with negotiating a lease (this variable being largely dependent on the commercial and legal attitude of the negotiating parties).

Limiting the number of variables in stochastic analysis has two benefits. Firstly, the larger the number of variables being considered, the more likely it is that unrealistic scenarios are generated; unrealistic outcomes can be generated due to the challenges in articulating correlations in inter-variable relationships. Secondly, it is uneconomic to deploy effort in describing probability distributions and correlations for variables that have a low impact on project returns.

DESCRIBE VARIABLE RANGES

Once the key project variables have been identified, the range of uncertainty surrounding that variable must be established; the uncertainty margins should be sufficiently wide so as to encompass any lack of adequate data or error embedded in the base data assumptions. Objective expert opinion and observations of previous performance should be used to ensure that the full range of plausible outcomes in the future value of a variable is captured. In some cases statistical analysis will be available, however in most cases, variable ranges and most likely outcomes can be sought through interrogating embedded experience and expert opinion. The Delphi method provides a structured and interactive technique for forecasting possible variable outcomes. Delphi also provides convergence around the central or "most likely" outcome for a variable; statistically this is the equivalent of the mean value.

ASCRIBING PROBABILITIES

Since there is a "most likely" outcome for a variable (this will be the single value used in deterministic analysis), it follows that other "less likely" outcomes must have a lower probability of occurring. Ascribing probabilities to these outcomes is what differentiates stochastic analysis from the conventional, single number, deterministic approach. Progressive organisations will benefit if open and frank discussions are generated between analysts, managers, experts and decision makers in considering and describing outcomes that differ from the official "single number" view of the future.

In property, one of the most difficult variables to accurately predict is the likely period of vacancy following speculative project completion. The chance that the income generating space generates no income for a period of time that is 10, 20, 30 or 100 per cent longer (or shorter) than forecast is significant. If described by a normal distribution curve, one should expect to see broad standard deviation evident.

Face rental, on the other hand, is a variable whose risk is diversifiable through the provision of landlords' incentives. A normal distribution curve for face rental should demonstrate a relatively small standard deviation and so be taller and narrower than a curve describing periods of vacancy.

Normal distribution relies on there being a sufficiently large number of observations of variable behaviour being available, and this is not always possible. Other distributions commonly used for the description of data include triangular, step and uniform probability distributions. The analyst will need to use judgement, skill and experience in determining which probability distribution best describes a given variable.

CORRELATIONS

Recognising the existence of interrelationships between variables is central to ensuring that realistic outcomes are generated from Monte Carlo analysis. An obvious example of dependency is the relationship between the demand for a product and its price. For example, if effective rents were set at an over-market rate, for vacant space, then periods of vacancy would increase since rational tenants would not pay a higher rent than the rest of the market demanded for comparative premises. If the constraint imposed by this correlation was not recognised then the Monte Carlo model would produce some unrealistic outcomes because the selection of input variables for simulation runs is randomly generated from the probability distributions that describe those variables.

It is important therefore to analyse the known, or suspected, inter-relationships between the selected input variables and to describe those constraints prior to generating simulation runs.

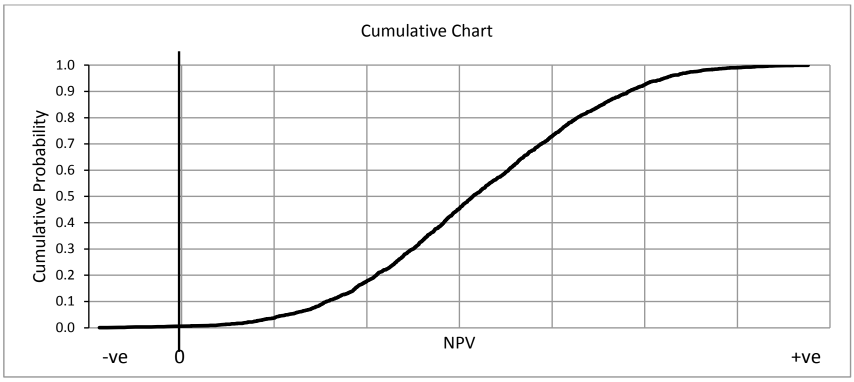
RUN MODEL

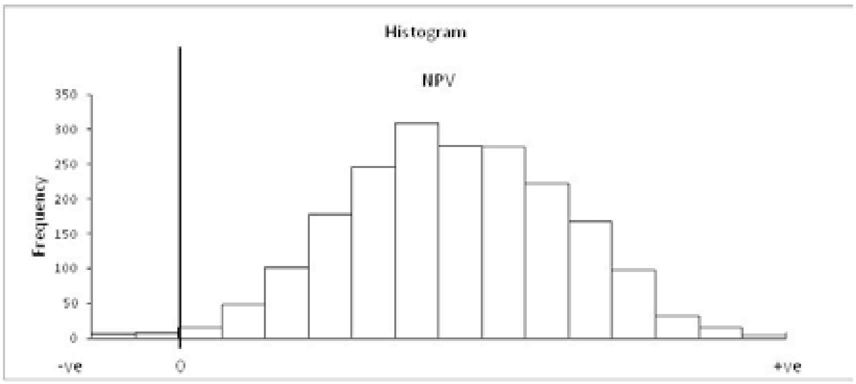
Once all of the assumptions, including constraints, have been entered into the model it is possible to conduct simulations based on a random selection of values within the specified ranges, probability distributions and correlations that describe the key variables.

SIMULATION RESULTS

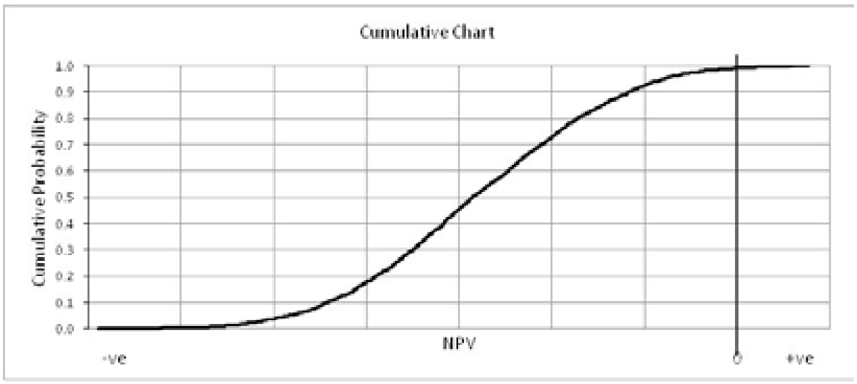
Some examples of project outcomes and commentary on interpretation are shown below:

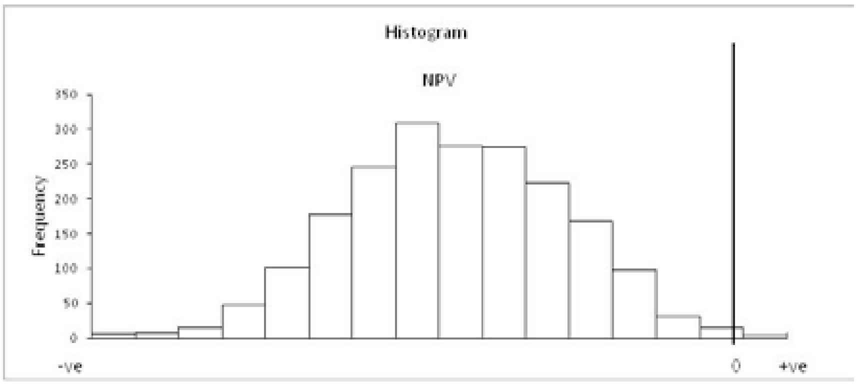
▶ **Cumulative chart and histogram for a project indicating that almost all possible outcomes will result in a positive NPV - this project would be attractive to most investors**



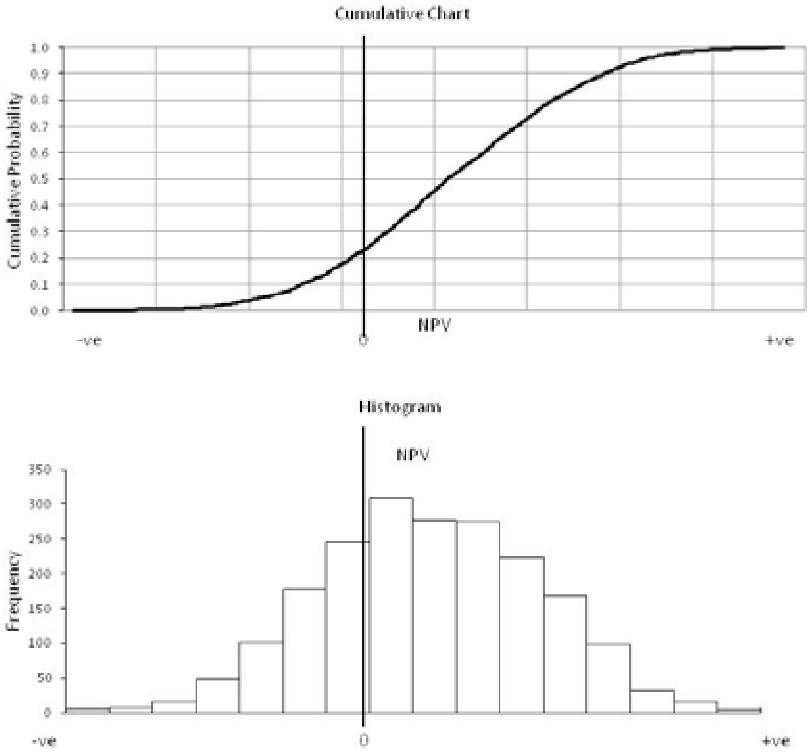


▶ **Cumulative chart and histogram showing that almost all possible project outcomes provide a negative NPV - this project would be rejected by rational investors**

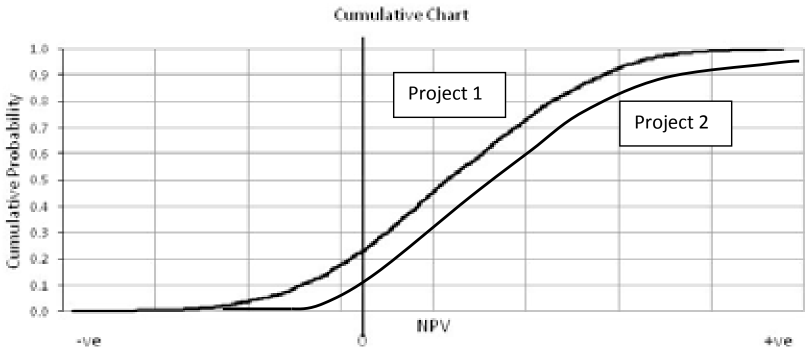




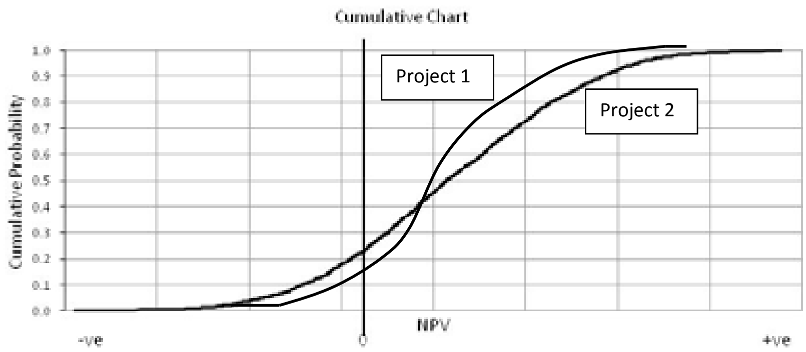
▶ **Cumulative chart and histogram showing an intermediate risk profile that could be acceptable to a rational investor, provided that the risks of a negative NPV were fully understood and capable of being managed by the skills and experience available to the project team**



▶ **Cumulative chart showing a more attractive return profile for Project 2, over Project 1 - there is less risk of a negative NPV with Project 2 whose likely returns always exceed Project 1 (note that all probabilities sum to 1)**



▶ **Cumulative chart showing Project 2 with a higher NPV but greater risk of negative returns**



Project 1 is less risky but provides a lower maximum NPV than Project 2. The selection of one project over the other will be a matter of risk appetite for the investor. A fully informed decision can be made with regard to the relative risk and return profiles between the projects. Note however, that a deterministic appraisal would simply present a higher and lower NPV traditionally resulting in the riskier (higher NPV) Project 2 being selected.

DISCUSSION

Yogi Berra, an American baseball coach famed equally for his game skills and for fracturing the English language, once said *"the future ain't what it used to be"*, probably meaning that our view of the future is continually being revised based on the updated information that we receive.

Continuing dislocation in the markets ought to bring about a new respect for Berra's observations; it should also provide impetus for organisations to reassess the way that they predict their own performance. An organisation's potential for profitability can be assessed as the sum of all the gainful enterprises that it is able to generate and carry out. Selecting the most favourable opportunities and avoiding unnecessary risk is an elemental charge for management who should utilise the best tools and techniques available for that task.

When faced with an uncertain future, the past is often the best place to turn to; by analysing and understanding previous performance a lens is provided through which future variability can be foreseen.

Despite the plethora of literature available on the potential volatility in capitalisation rates, property yields, market fundamentals and investment returns, there has been little or nothing written on the ability of property organisations to accurately predict key variables such as rents, incentives, vacancy and capital expenditure that they must habitually forecast, use to inform their investment decisions and ultimately deliver upon. The use of deterministic feasibilities is commonplace - it is a rare property development proposal that forecasts probable volatility in projected IRR, yet the high hurdle rates for development are proof enough that it is a risky and uncertain business deserving of better and more intelligent analysis.

While deterministic appraisal remains valid, it has to be recognised that it fails to offer the in depth assessment that is available through the Monte Carlo technique. By illustrating the range of possible investment returns, Monte Carlo enhances the decision making process, allows for meaningful comparison between competing projects and highlights those areas in a project that would benefit from the closest risk management.

On a cautionary note, the truism "rubbish in, rubbish out" holds for Monte Carlo as with all other attempts to model real world uncertainty. If incorrect data is entered into the model, the outputs must also be equally incorrect.

RISK FACTORS IN COMMERCIAL PROPERTY FEASIBILITY STUDIES – M CRUDDEN

RISK	COMMENTS
Capital Expenditure (Capex)	The uncertainty in forecasting the capital expenditure necessary to successfully complete any physical works required to refurbish or represent property. If Capex costs are different than forecast, there will be a concomitant inverse effect on the NPV of future cash flows.
Capitalisation Rate	Relates to the uncertainty in the rate used to derive property value through the capitalisation of net income approach to valuation. Capitalisation rate movement has an inverse relationship to property value.
Construction Risk	The uncertainty in completing programmed construction activity on time and at cost. Construction risk may have an effect on the NPV of future cash flows wherever a) lease commencement is dependent on the timely completion of construction activity, or b) the costs associated with the fulfilment of the original, or varied, scope of works is uncertain.
Discount Rate	The uncertainty in accurately compensating for the future risks to income through the discount rate selected in discounted cash flow calculations.
Downtime	The uncertainty in accurately predicting the period of, non-income producing, vacancy before lease commencement date(s).
Face Rent	The uncertainty in accurately predicting the rent, exclusive of any incentives, that a tenant will agree to pay.
Incentive for Lease	The uncertainty in accurately predicting the level of inducement paid to a tenant in order for the tenant to enter a lease at a higher contract rent than would otherwise be the case.
Lease Term	The uncertainty in accurately predicting the temporal duration of a lease. The end of every lease term introduces a risk that a tenant will vacate potentially causing cash flow interruption, downtime and a new lease incentive to be paid.
Rental Growth	The uncertainty in accurately predicting the (typically annual) face rent increases that can be negotiated with a tenant.
Tenant Covenant	The uncertainty that a tenant will be able to meet its covenant to pay rent during the lease term.
Terminal Capitalisation Rate	The uncertainty in accurately predicting the capitalisation rate used to calculate terminal value at the end of a cashflow period.
Vacancy	Relates to the uncertainty in predicting the amount of a property that may remain vacant even though leases for other space in the same property have commenced. Vacancy can be viewed as a "spare capacity" charge to the building.

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