Institute of Actuaries of Australia

Financial Modelling of Project Financing Transactions

Prepared by:
Robert J Lawrence MSc
Jasmine Lee FIAA MCom

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The Institute of Actuaries of Australia
Level 7 Challis House 4 Martin Place
Sydney NSW Australia 2000
Telephone: +61 2 9233 3466 Facsimile: +61 2 9233 3446
Email: insact@actuaries.asn.au Website: www.actuaries.asn.au

Contents

1

Introduction to Project Financing

By project financing we mean forms of financing that primarily have recourse to the cash flows generated by a project, rather than the balance sheet of the sponsors of the project. From a sponsor's perspective project financing is a way of minimising the impact that a project not performing well will have on its own business. As such project financing is emerging worldwide as the preferred alternative for financing infrastructure developments, private public partnerships and other large-scale projects.

Of course, the attraction of project financing to sponsors does not imply that this is a form of finance appropriate for financing "risky" projects, such as unproven technological developments. That is the domain of venture capital.

On the contrary, lenders to a project financing will be primarily concerned with satisfying themselves that, even on conservative assumptions, the project will have the capacity to service debt. As lenders are not generally looking to share in profits they will not be as concerned with the project's upside expectations as the sponsors and equity investors.

Not surprisingly, project financing essentially revolves around the use of financial engineering to allocate risks amongst the various parties to the financing in such a way that no one party assumes full credit risk for the project and yet the credit risk to the lenders is satisfactory to them.

This allocation of risks mainly proceeds through the establishment of long-term contracts, guarantees and agreements between the various parties (sponsors, lenders, suppliers, contractors, government bodies, insurers, swap counterparties etc) that aims to place each project specific risk with the party best able to bear that risk. It is the complexity of these contractual arrangements combined with each project's unique characteristics that makes project financing a challenging and complex area of modern corporate finance.

In the Australian market a number of people with actuarial training have established successful careers in project financing; often involved in the development and review of the complex models underlying the evaluation of project financing opportunities.

2

Project Financing Models

2.1 The Role of Models

From our brief overview of project financing it will be apparent that in order to assess and evaluate a project financing it is necessary to develop a model ("financial model") that forecasts the cash flows of the project and reflects the contractual obligations of the various parties. Given the overriding importance of risk allocation to project financing the underlying financial model needs to be flexible enough to allow the impact of changes in the key assumptions to be assessed.

The importance of the financial model to project financing cannot be understated. It is the primary tool for evaluating and assessing the benefit of a project financing and is continually used during negotiations to quantify the impact on the project's cash flows of changes to the underlying contractual arrangements. Potential lenders to a project financing will use the financial model as a necessary tool to complete their credit risk analysis; running various scenarios through and noting the impact on key financial ratios.

As a general rule most financial models are written using Microsoft Excel, often with the use of macros and occasionally with Visual Basic code. The significant increase in the computational power of personal computers combined with the flexibility of modern spreadsheets has directly contributed to the increased sophistication and detail of financial models for project financing.

In simple terms the role of the financial model is to project the cash flows arising from a project (that is, revenue less costs and taxes) in order to derive cash flow available for debt service. From this information debt cover ratios and returns to equity can be derived. Various factors will complicate the financial model and challenge the modeller. Some examples are:

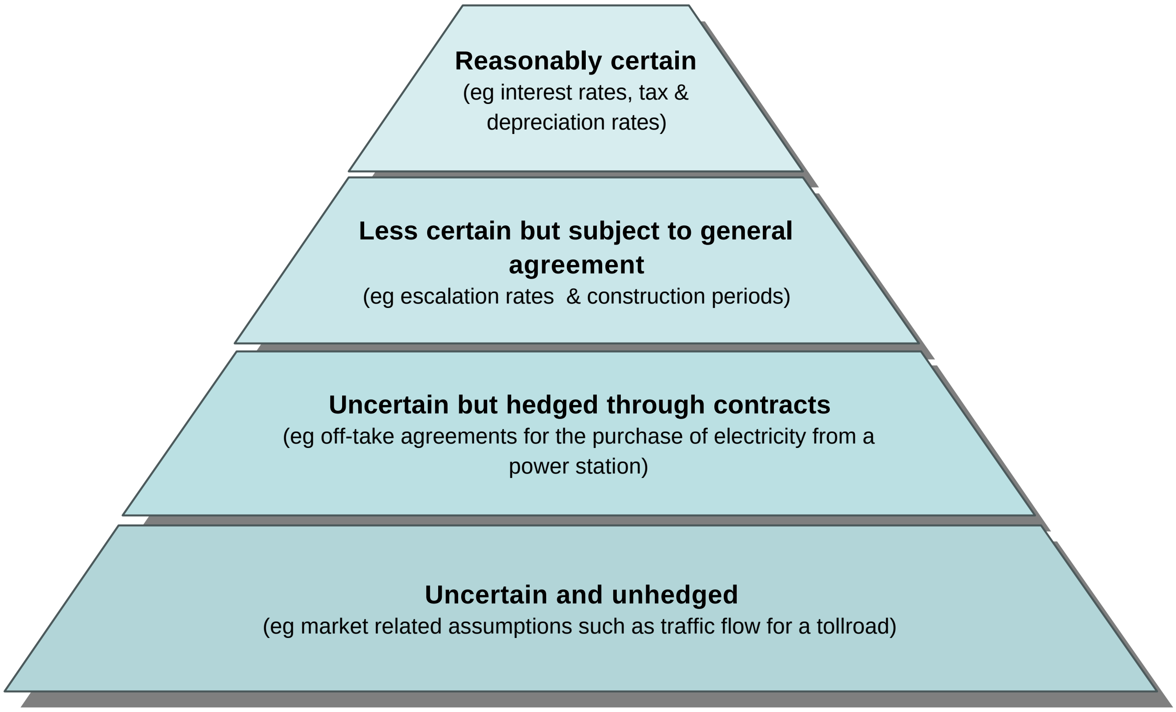
1. Regulatory pricing regimes (complicates the calculation of revenue).

2. Lock-up provisions (complicates the determination of how cash is to be distributed).

3. Ownership structures (complicates the allocation of cash and tax).

4. Risk sharing (can complicate many features such as the provision of debt financing, the use of reserve accounts and the cash flow waterfall).

In setting up the financial model a large number of assumptions will be made regarding the project. These assumptions will be the responsibility of a number of parties, including various advisors. With regard to these assumptions they can be categorised into four tiers:



The last tier of assumptions will usually be determined by either a form of best estimation or statistical analysis.

Clearly the primary role of the financial model is to allow for the impact on the cash flows of the project of variations in these key assumptions to be readily determined. Especially for those assumptions which are uncertain and not fully hedged.

A financial model for a project financing is by necessity a cash flow driven model. Balance sheets and profit & loss statements are often included as management reports, but it is the source and application of cash that is pertinent.

2.2 Risks of Models

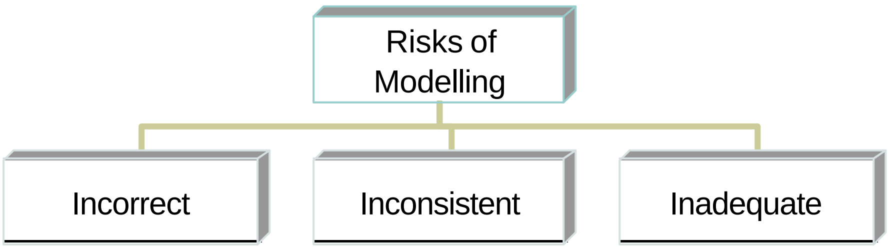
"Spreadsheet end-users, who by definition are interested in solving a problem, are unlikely to acquire professional spreadsheet programming skills with experience.

This seems to explain the troubling experimental results: experienced spreadsheet users are but amateur spreadsheet programmers. Although their experience presumably taught them much about their problems, it taught them little about spreadsheet programming."

Spreadsheet Engineering: A Research Framework
Thomas A. Grossman 2002

The critical role that the financial model plays in the evaluation of a project financing means that a very high degree of reliance is placed on the results of the model by a number of parties. Clearly any errors or inadequacies in the financial model can seriously affect the evaluation process.

The risks associated with a model can be characterised in one of three ways:



Incorrect Modelling Risks:

> These are outright errors in the mathematical formulae or logic of the model. For example, a formula being incorrectly implemented or incorrect cell references in a formula.

Inconsistent Modelling Risks:

> This is where the model is internally inconsistent or the model is inconsistent with the project documentation. For example, assumptions in the model not matching those in the project documentation or debt interest being calculated by different conventions in different sections of the model.

Inadequate Modelling Risks:

> This is where the model is not sufficient to meet its intended purpose because it either does not model aspects of the project finance transaction appropriately or it does not model them at all. For example, assumptions being hard-coded in

formulae, meaning that the model's results become incorrect when these assumptions change, or a contractual obligation, that directly impacts on cash sharing, has not been modelled.

Clearly the risks we are referring to relate, to various degrees, to all modelling that companies undertake with the use of spreadsheets. They are by no means unique to the world of project financing. There have in recent years been well-publicised cases of major companies suffering significant financial losses as a result of errors in spreadsheet models that they had been relying on.

It is worthwhile to reflect on the wider issue of the use of spreadsheets.

Spreadsheets, especially Microsoft Excel, are used by companies world-wide to perform complex calculations, maintain databases and produce high-quality reports. They are used for a wide range of purposes including revenue and cash flow projection, asset valuation, business planning, calculating investment returns and comparing alternative means of financing.

Major investment and financing decisions are made on the basis of results produced by spreadsheets. Clearly it is imperative that senior management be able to rely on these results.

However, it is the ease of use and flexibility of spreadsheets that, paradoxically, represents their greatest danger. Very few companies have strict policies on developing and testing spreadsheets, and even fewer companies have anyone responsible for spreadsheet development. This means that most companies rely solely on the developer for professional methods and controls.

The development of spreadsheet models is invariably undertaken in an environment that does not include the disciplines of professional programming. Consequently, lack of proper design and inadequate testing can result in calculation or logic errors remaining undetected. Poor spreadsheet modelling can cost money because of errors, the time required to develop or change models and incorrect business decisions.

Research has shown that error rates in project financing models can be as high as 10%. Section 5 of this paper provides some statistics on error rates collected by Mercer Finance & Risk Consulting. Out of the thirty highest value projects reviewed during the 2004 financial year, nine (that is, 30%) exceeded the 10% threshold; four exceeded the 15% threshold; and one exceeded the 20% threshold.

Given the above general comments on the risks of developing spreadsheet models, what is unique about financial models developed for project financing? It is the environment under which project financing is undertaken that has resulted in more focus on the underlying risk of modelling. Consider the following points:

- A number of parties are relying on the financial model, not just the company that developed the model. They will want more than the assurance of the developer that they can rely on the model.

- The large amounts involved tend to focus everyone’s mind on the model. If a consortium is bidding for a $1 billion project then they will be fully aware that an error in the model that affected their bid price by as little as 2% could lose them the business. (Of course any large company will have internal models that can affect its financial results in a significant manner – the “externalisation” of a project financing tends to provide the impetus for this focus.)

- The time pressures on the development of a financial model for a project financing opportunity, especially in a bid situation, can be extreme. It is not at all uncommon for modellers to work around the clock in the final days before a bid submission. The management team running the negotiations tend not to have an understanding of how difficult and time-consuming model development can be and expect substantial structural changes to be made to a model quickly at odd times of the day. This does not auger well for good modelling practices!

The risks of modelling are well understood in the project financing industry, particularly in the Australian market, and these risks are beginning to be appreciated in other industries as well.

2.3 Risk Management

To minimise the risk arising from incorrect, inconsistent or inadequate modelling it is necessary to actively manage this risk.

The way that this is typically handled in the project financing industry is for a consultant to be engaged to review the model. Often this consultant is engaged by the lenders to a project; due to their heavy reliance on the model for their risk assessment.

A consultant engaged to review a financial model will, typically, perform the following tasks:

- Undertake a detailed examination of the model's logic, including any algorithms, and perform a cell-by-cell check of all calculations within the model.

- Verify that input assumptions have been applied correctly.

- Review the project documentation to ensure that relevant formulae and covenants have been correctly incorporated into the model's logic.

- Advise on the overall design of the model and how it may be improved.

- Comment on the model's ability to successfully test sensitivities using a range of assumptions.

- Provide written confirmation that the model can be relied upon for its intended purpose.

Having an independent consultant review the model is necessary. The model developer is too familiar with the model to be expected to find errors. Having an independent party that is not otherwise involved in the project review the logic and mathematics is the best way of managing the risk of incorrect modelling.

Simply running various changes in input assumptions through the model and confirming that the results are "reasonable" is insufficient. This means of testing a model, although useful, may not identify an error that affects all scenarios. The most common example of this is where an assumption is hard-coded into a formula, so that the formula's value is unaffected by changes in this assumption. Further, it is not uncommon for a financial model to have many instances of nested logic whereby the results of a formula may depend on the values of other parameters. Testing all possible branches in a model's logic through variations in input assumptions is very difficult.

Typically, the consultant will largely deduce the details of the proposed transaction from the model itself; without the pre-conceived notions of the various parties to the project financing. This is a valuable part of the risk management process. For example, from the model's logic the consultant may note that certain conditions need to be met before profits are shared. In seeking confirmation that this is correct, the modeller may respond - "No, not those conditions" – thereby alerting the consultant to the fact that the model is inconsistent or inadequate.

The point is that the best chance of capturing inconsistent or inadequate modelling risks is for someone completely independent of the transaction to derive the details of the transaction from the model. This is a good test of whether or not the model reflects the same deal that the lawyers have drafted. Often it does not, for the simple reason that lawyers and modellers think differently.

In the project financing industry in Australia the completion of an independent review of the underlying model's logic and mathematics is a standard part of the due diligence process. Usually the review process is referred to as a "financial model audit". It is worth noting that an independent financial model audit is typically one of the requirements for lodging a bid in a competitive tender situation. No party wishes to see the bid process invalidated by a financial model that is incorrect, inconsistent or inadequate.

The skills that the consultant reviewing a financial model needs include the ability to think logically, an understanding of the financial instruments used in project financing and a good grasp of the fundamentals of cash flow valuation.

Overseas the consultant chosen to conduct a financial model audit is usually one of the major accounting firms. However, it is pleasing to note that in the Australian market actuarial firms are often preferred for this role. People with actuarial training are more likely to view the financial model as a dynamic rather than static model and thereby focus on the logic rather than the results based on current input assumptions. Furthermore, cash flow valuation is one of the strengths of the actuarial profession and, as has been discussed earlier, cash flow is integral to project financing, not financial statements.

3

Enhancing Project Financing Models

3.1 Risks Underlying Project Financing

There are a number of project specific risks underlying any project financing. Many of these risks are dealt with through contracts; others will be borne by the appropriate party.

The following diagram illustrates the main risks:

Construction

- Completion Risk
- Cost Overrun Risk
- Performance Risk
- Environmental Risk

Operations

- Regulatory Risk
- Off-take Risk (eg electricity purchase in a Power Project)
- Market Risk (eg traffic flow in a Tollroad Project)
- Performance Risk
- Environmental Risk

Various advisors will be engaged to provide specialist advice on the underlying risks, especially construction, regulatory, market and environmental. In providing this advice they will draw upon experience with similar projects, where available.

Following a systematic review of the risks an understanding of the structuring that can be used and the contractual agreements that are required will be reached.

The financial model will start to develop during this risk review and be used to quantify the financial impact of the various risks and cash flow structuring.

3.2 Deterministic Risk Modelling

The financial models developed for project financing are by nature deterministic, that is, for an assumed set of inputs the model produces a single set of outputs. The outputs are determined by the logic and calculations within the model.

Obviously a great deal of effort is put into determining what values the various input assumptions should take in the model. As some input assumptions are uncertain it is necessary to examine the impact of varying assumptions on these inputs.

Accordingly it is usual during the evaluation of a project to run a very large number of sensitivities through the financial model, varying the key input assumptions through a range of "possible" values. Often hundreds of sensitivity runs will be performed, especially by the lenders, to understand the risk profile of the project. Varying the key input assumptions will enable the key risk drivers to be identified, that is, those assumptions whose values impact the project's evaluation.

Apart from sensitivity analysis it is usual to undertake scenario testing, whereby a number of the key input assumptions, as identified by the sensitivity analysis, are varied together. Essentially a number of "likely" scenarios regarding the project's future cash flows are evaluated. Usually at least three scenarios are constructed:

Base Case –

> This includes the assumptions agreed between the relevant parties as representing a conservative assessment of the project's risks. This case is used for setting the scheduled amortisation of debt funding and can be regarded as the lenders' case.

Worst (or Downside) Case –

> This includes the assumptions that the relevant parties regard as being a pessimistic assessment of the project's risks. This case is used for setting the level of the reserve accounts and for testing flexibility in loan principal repayments and the impact of lock-up provisions. As a general rule the parties would not proceed with the project on the basis of these assumptions. Accordingly, their assessment of the project's risks should have indicated that this combination of assumptions is unlikely.

Best (or Upside) Case –

> This includes the assumptions that the relevant parties regard as being an optimistic but likely assessment of the project's risks. This case is used for testing pre-payment and re-financing options and can be regarded as the sponsors' case.

Other scenarios may be tested, depending on the results of the sensitivity analysis.

Sensitivity analysis and scenario testing are useful aids to understanding the financial impact of a project's risks. However they provide no information on the likelihood of a particular scenario eventuating.

3.3 Stochastic Risk Modelling

"The lack of historical data on the occurrence of events that are being guaranteed against limits the usefulness of actuarial or econometric methods for measuring risks and expected losses. The Colombian government finds it more useful to use a model based on contingent claims theory and Monte Carlo simulations. This allows projections to be made based on multiple scenarios with different probabilities in order to determine the probability of bad states of the world."

Clemente del Valle, Director General
Ministry of Finance and Public Credit
Colombia

The previous section discussed the uses of deterministic methods such as sensitivity analysis and scenario testing in measuring the risks underlying project financing. As each project financing deal is unique and data records are often missing or of low quality, more advance modelling approaches are sometimes required, including stochastic risk modelling.

Stochastic risk modelling can be implemented in both aspects of project financing – the financing side and the operational side. Risk factors on the financing side are uncertain future variables such as floating interest rates, inflation rates, exchange rates and credit risk premiums; whilst on the operational side, a wider range of risk factors may be involved, comprising variables that impact on the timing and/or the magnitude of a project's expected cash flows. Common examples of stochastically modelled variables on the operational side, by type of project, are as follows:

Type of Project	Stochastic Variable
Power & Energy	Electricity Pool Price
Transport - Toll Roads	Traffic Flow
Hospitals/Schools/Prisons	Wages Inflation
Resources - Mining	Exchange Rate
Telecommunication	Volume
Oil & Gas	Production Capacity
Airports	Passenger Numbers

Take an airport project as an example. Regardless of whether the proposal is a refinancing deal or the construction of a new terminal, the variability of passenger numbers, among other risks, imposes uncertainty on the airport's future cash flows. It therefore adds value to the project's decision making process to model such a risk. S*tochastic risk modelling* is especially useful here.

A pure spreadsheet risk model is *deterministic*, which means that the inputs are fixed (one value to one cell). It will only reveal a single outcome at a time, generally the most likely or average outcome. If alternative outcomes are required in order to analyse the effect of varying inputs on outputs, one needs to manually change the inputs in the model, that is, *scenario testing*. In contrast, a risk analysis that combines a spreadsheet model and simulation can automatically analyse the effect of varying inputs on outputs of the modelled project, by providing a range of outputs with associated probabilities.

Suppose that, without the aid of simulation, the most *likely* total NPV of a project amounts to $30 million. How likely is *likely*? Is it 75% or 100% certain? A simulation approach can provide the probability of a given outcome.

One type of spreadsheet simulation is Monte Carlo simulation.

Monte Carlo simulation requires each uncertain variable to be defined as an *input distribution*, that is, a range of possible values with associated probabilities. The type of input distribution to elect is subjective, based on the conditions surrounding that variable. Many types of input distributions exist. Common types include *Uniform*, *Normal* and *Binomial*:

- The Uniform distribution may be appropriate when there is an equal chance for the uncertain variable to take a value within the minimum and maximum values.

- The Normal distribution may be appropriate when mean and standard deviation values of the uncertain variable are available from historical data or other reliable source.

- The Binomial distribution may be appropriate when there is a fixed and known probability of an event arising. For example, if the probability of an event arising is 10%, the uncertain financial outcome of the event will have a 90% probability of taking a zero value and a 10% probability of taking the most likely value.

In the case where uncertain variables are related to each other, that is, the value of one depends on the value of another in some way, Monte Carlo simulation treats the variables as being *correlated*. Correlation coefficients are specified to ensure that this relationship is maintained between the values that the uncertain variables take during the random selection process.

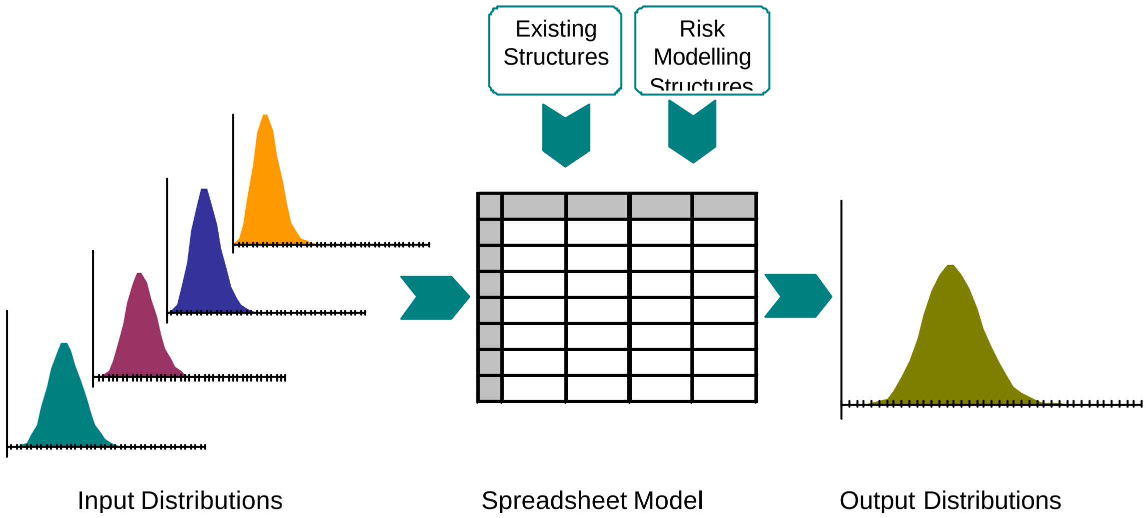
A simulation calculates multiple scenarios by repeatedly sampling values from the input distributions for the uncertain variables. During a single trial, the model randomly selects a value from the input distribution for each uncertain variable and then recalculates the spreadsheet and saves the outcomes in memory.

If a simulation for 50,000 trials is run, then 50,000 possible outcomes will be created, compared to the single outcome in the deterministic spreadsheet. These can be analysed to get *expected cash flows*, and sorted to determine how likely it is that the overall outcomes will exceed various thresholds.

In statistics, these thresholds are termed *percentiles*. They can be loosely called probabilities but in fact, they represent the actual ranking of a single outcome within the 50,000 outcomes. For example, if the total NPV of $30 million predicted from the deterministic model is at the 47th percentile, we can then conclude that there is 47% certainty the total NPV for the project will not exceed $30 million.

Returning to the previous example on airport passenger number, suppose it is assumed that the annual number of passengers follows a Poisson (x) input distribution and that the growth rate of annual number of passengers is y% pa throughout the project life of n years. Further suppose that all other inputs are deterministic.

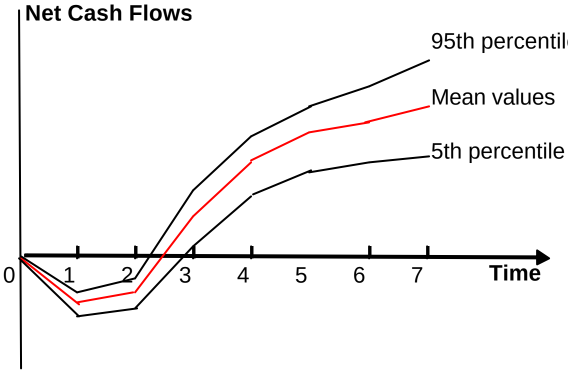
During the first simulation trial, the simulation programme generates a series of n sequential Poisson random variates, each representing the annual number of passengers in a projection year. These random variates are fed into the existing cash flow model as inputs, as illustrated in the following diagram:



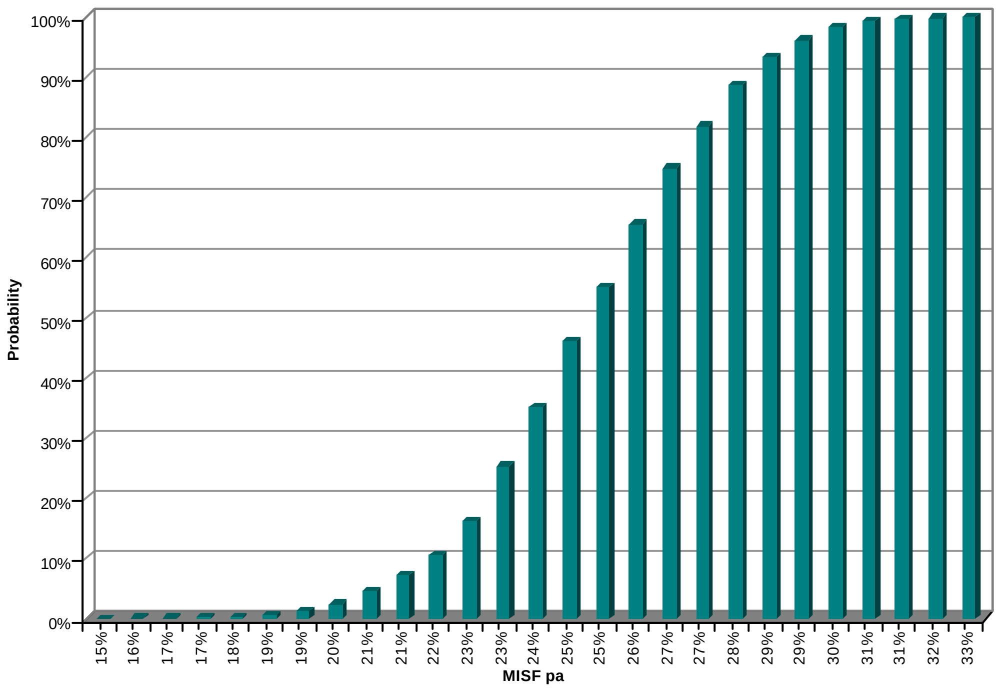
The cash flow model then produces the series of n projected net cash flows outcomes, to be stored as the results of the first trial. Other outcomes which may be of interest are NPVs at each projection year, the yield, Debt Service Ratios at each projection year, the number of equity lock-ups, the pay-back period and the tax payment pattern.

This process is then automatically run another 49,999 times. The stored results for each outcome of interest form an output distribution, from which we can draw meaningful conclusions such as:

- On the assumptions used, there is 90% certainty that the project's net cash flows at each projection year will lie between the graphed ranges below.



- On the assumptions used, there is 65% likelihood that the project's expected after tax yield will not fall below 26%pa.



In conclusion, Monte Carlo simulation adds the dimension of dynamic analysis to project financing models by making it possible to build up random scenarios, which are consistent with analysts' key assumptions about risk. It enables a project financing model to answer questions like, "What is the probability of the NPV exceeding $30 million?" or "What are the chances of losing money on this project?"

However, it is worthwhile to note that the results are only as good as the assumptions. If the input distributions are unreliable then the output distributions will be equally unreliable.

4

Role of Actuarial Profession

The actuarial profession in Australia has had a long involvement in project financing.

A number of actuarially trained people are involved in work based around financial modelling for project finance; either developing models as part of the project finance team in a bank or reviewing models as part of a consultancy.

Some actuarially trained people have progressed into very senior management roles in investment banks; taking a lead role in the negotiation and arrangement of transactions.

It is probably the case that the Australian actuarial profession has had more involvement in corporate finance than its colleagues overseas.

The genesis of this is undoubtedly the arrival of leveraged leasing as a form of big-ticket financing in Australia during the late 1970's.

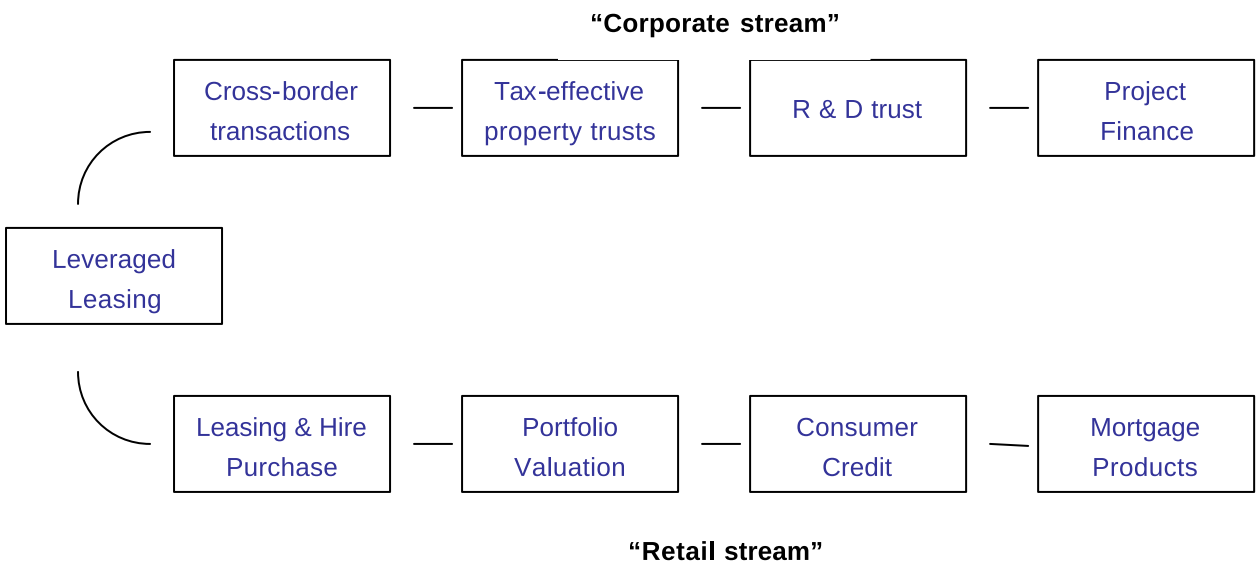
Leasing is a means of financing that transfers tax benefits applicable to the leased equipment from the lessee to the lessor. Leveraged leasing increases the value of these tax benefits through the use of financial leverage.

At the time of its advent in the Australian market, high corporate rates of taxation combined with generous capital and investment allowances made leveraged leasing extremely attractive to lessors and lessees. Needless to say, banks were keen to provide this form of finance and companies were keen to use it for financing their big-ticket capital expenditure.

The problems faced by potential players in the leveraged leasing market were, initially, a lack of technical expertise and, soon afterwards, a need for independent confirmation of transactional arrangements being put forward.

In the Australian market the actuarial firm E.S. Knight & Co., later acquired by Mercer, was an active participant in the establishment of the leveraged leasing market in Australia. The actuarial skill-set, specifically the ability to analyse complex financial problems and the solid grounding in compound interest, was quickly recognised as being of value to players in the leveraged leasing industry. Development of PC-based programs to analyse the cash flows generated by a leveraged lease and the introduction of mathematical techniques to optimise the debt repayment profile were all undertaken in Australia by people with actuarial training.

As the finance market in Australia has continued to develop the actuarial profession in Australia has continued to be involved; predominantly through the use of its analytical and cash flow valuation skills. Two distinct streams of involvement in finance by the actuarial profession in Australia can be traced from the advent of leveraged leasing – a "Corporate Stream" and a "Retail Stream" – as indicated in the diagram below.



It is interesting to note that the use of stochastic modelling has grown in the "Retail Stream" over the last couple of years with products such as reverse mortgages becoming more popular.

Clearly there will continue to be opportunities for actuarially trained people in project financing, particularly with the modelling aspects. There are also potential opportunities for more use to be made of stochastic modelling in project financing; in assessing the financial impact of the key risk drivers. It is to be expected that actuarially trained people will be involved with these opportunities as they have the necessary skills and rigour.

5

Appendix – Statistics on Model Error Rates

The table on the following page sets out some statistics on error rates in project financing models. These statistics are based on the authors' own professional experience. They are based on the thirty most financially significant projects that Mercer Finance & Risk Consulting reviewed during the financial year ending 30 June 2004. (Note the details are not ranked in any particular order.)

For the financial models related to these thirty projects the average number of unique formulae per model was 2,182 and the average number of issues raised during the initial review of these models was 151 (or, 6.9% of the number of unique formulae). The average number of versions required in order to produce a model that could be "signed-off" was 6.

With regard to these statistics, we make the following remarks:

- The number of issues raised only refers to the issues raised whilst auditing the initial version of the financial model and does not include issues raised for subsequent versions of the financial model.

- The high number of revisions made to some of the financial models is related to the fact that these models were being developed for bids. Accordingly, a number of changes made to these models were a result of negotiations during the bid process and do not necessarily mean that it took a large number of revisions to fix errors noted.

- The size of the model does not correlate at all well with the complexity of the model. This is well illustrated by the table. For example, model number 18 was only 0.8MB in size but had 1,299 unique formulae. On the other hand, model number 24 was of size 3.8MB but only had 592 unique formulae.

	Size (MB)	No. of Unique Formula	Issues in First Phase of Audit		No. of Revisions Required to Model
			No. of Issues	As proportion of Unique Formula	
1.	5.1	1,300	125	9.6%	4
2.	3.2	982	164	16.7%	6
3.	11.1	3,828	144	3.8%	5
4.	3.0	797	106	13.3%	7
5.	2.8	1,445	154	10.7%	8
6.	18.3	3,351	209	6.2%	5
7.	1.9	1,559	49	3.1%	3
8.	13.5	3,059	155	5.1%	6
9.	6.3	2,500	149	6.0%	4
10.	17.7	4,021	161	4.0%	7
11.	12.4	1,373	198	14.4%	4
12.	2.0	668	150	22.5%	8
13.	9.8	2,871	251	8.7%	2
14.	22.6	4,825	239	5.0%	17
15.	4.2	2,667	232	8.7%	6
16.	25.1	3,555	116	3.3%	5
17.	12.0	5,406	410	7.6%	5
18.	0.8	1,299	90	6.9%	6
19.	3.7	3,335	307	9.2%	14
20.	2.3	769	120	15.6%	16
21.	1.3	1,895	81	4.3%	5
22.	3.6	2,086	117	5.6%	4
23.	1.0	990	51	5.2%	4
24.	3.8	592	47	7.9%	8
25.	7.2	2,291	153	6.7%	6
26.	1.9	748	120	16.0%	3
27.	2.7	1,059	60	5.7%	2
28.	15.6	4,519	201	4.4%	7
29.	0.9	578	63	10.9%	4
30.	1.7	1,077	108	10.0%	2