RISK MANAGEMENT TOPIC PAPER No. 3

MONTE CARLO SIMULATION AND THE ART OF AVIATION

By David Montague

PREPARING FOR TAKE-OFF...

The only thing you can be sure of as you set off on your new social housing project is that every assumption in your financial appraisal is wrong. The Chancellor will not keep inflation at 2.5%, rents will not rise by RPI + % and major repairs will not cost what your survey predicted. Why? Because we live in an uncertain world, and we can only guess what the future holds. Your guesses might be informed or instinctive, they might reflect the world around you or your own personal bias, but even if you have some influence over your environment, you never know for sure what is under the floorboards until you lift them…

Wouldn't it be nice if, like the pilot of an aircraft, you could 'simulate' your journey before take-off into uncharted territory? Well the good news is that you can – a few hundred pounds will buy an easy - to - use business simulation package which bolts onto existing spreadsheet models, and helps to make sense of the risks we face before taking them. This paper explains how simulation can work in a business environment, using real-life examples.

But before the examples, a few words about what simulation is.

WHAT IS SIMULATION?

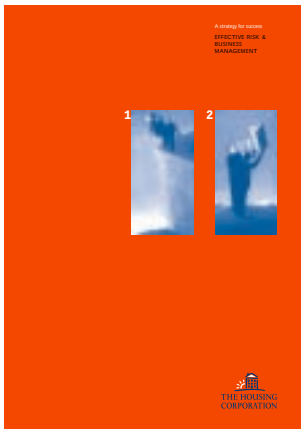
The conventional approach to financial modelling is to agree and input your assumptions into a spreadsheet, produce an 'answer' (perhaps net present value, or annual surplus) and then test the robustness of your appraisal using sensitivity analysis – what if costs were 10% higher, or inflation 1% lower? Sensitivity analysis is an essential part of the project appraisal process, but it fails to address several issues:

- In real life, variables are unlikely to change uniformly. Over the next 30 years inflation will vary, from year to year, probably within a range of values.
- Variables don't change in isolation. Inflation will change, but so will everything else. Some things will turn out better than expected, and others worse.
- Some variables will change because other variables do, and others will change independently.

Simulation packages enable you to factor these uncertainties into your project appraisal to assess the range of possible outcomes, the most likely outcome, the maximum potential loss, and the maximum potential gain.

Here is an example of how simulation differs from the conventional approach, staying once again with inflation. Rather than assuming that inflation will be 2.5% for the next 30 years, you can instead assume that inflation is most likely to be 2.5%, but:

- it could be as low as nil;
- it could be as high as 10%; and
- it could fall anywhere within that range.



EDITOR'S FOREWORD

This third paper on risk management is published as part of a short series sponsored by the Housing Corporation. The aim is to encourage development of best practice among housing associations. The papers follow on from previous publications that sought to introduce and develop effective risk management. In particular the publication in 2000 of Effective Risk and Business Management was designed to identify the elements of a risk management framework for housing associations.

The views expressed in these topic papers are those of their authors and not the Housing Corporation. It is hoped that they will stimulate discussion and the development of best practice in specific areas of risk management. Comments on the papers and suggestions for further topics would be welcomed. Roger Lustig

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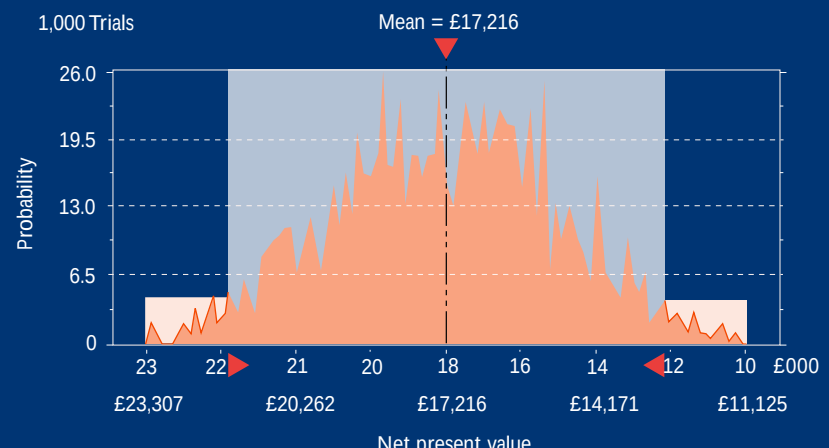
Diagram 1
Illustration of a social housing scheme



To add a further dimension, you can also assume that:

- when inflation is low, interest rates are likely to be lower;
- when inflation is high, interest rates are likely to increase; but
- every now and then, this won't be the case, and the two will move in opposite directions.

Using computerised simulation packages, a range of outcomes and dependencies are agreed for each key assumption in your financial model. As all key assumptions will then fluctuate within a specified range, the model will produce a different 'answer' (or 'output') each time it is run. The model can be run thousands of times in a matter of minutes. At the end of the process the outputs are displayed in a probability distribution. *Diagram 1* illustrates how a housing project might look.

In this illustration the model has been run 1,000 times. The range of assumptions used in the simulation for each key variable has been kept simple to illustrate the approach taken, and is listed in the table *Assumptions used in social housing scheme* on the next page.

The only interdependent assumptions set in the simulation model are between interest rates and inflation. The table of assumptions shows that interest rates are assumed to increase by 0.5% for each equivalent increase in cost inflation.

The probability distribution suggests that:

- the most likely outcome is a net present value deficit of £17,216;
- there is a 95% chance that the net present value will be a deficit of between £21,649 and £12,750.

So how can we use this information?

- The most likely result is a deficit. A prudent housing association will set aside at least this amount of surplus to fund the deficit.
- The maximum potential loss is £23,307. An even more prudent housing association will want to ensure that its free reserves can withstand this loss and the maximum impact of its entire development programme run through a single simulation.
- The range of values, or spread of risk, is fairly evenly distributed around the most likely outcome. As housing associations have limited reserves to invest and are likely to be faced with a number

Assumptions used in social housing scheme illustration

	Lowest	Most Likely	Highest
Capital cost	£128,000	£130,000	£132,000
Grant rate	64%	65%	65%
Starter rent	£ 3,900	£ 4,200	£ 4,400
Management & maintenance costs	£ 900	£ 1,000	£ 1,100
Inflation	1.5%	2.5%	3.5%
Real cost inflation	0.5%	1.0%	1.5%
Interest rate	6.5%	7.0%	7.5%

of opportunities, a project with less potential for loss and more potential for surplus would be a better investment.

- The range of outcomes is spread fairly widely around the most likely outcome (about 30% either way). This means the project is volatile, and if every project the organisation accepts is equally volatile, stakeholder confidence is likely to suffer.

In the commercial world this project would be rejected as it is almost certain to produce a loss. In social housing, life is a little more complicated. The majority of housing associations invest their reserves into new development – we should use simulation to allocate limited resources and manage risk more effectively.

SO WHAT ABOUT THE REAL-LIFE EXAMPLES?

The following sections give three real-life examples. Each example is followed by a few words covering practical use. Fasten your seatbelts; we are ready for take off…

1 *Market renting*

A number of housing associations are considering market renting as a natural extension to their core business. They understand that the risk associated with market renting is different, and that risk and reward go hand in hand, but what is an acceptable level of reward? Diagram 2 overleaf is an example of a 500 home market rent project.

In this example the output is the net present value (NPV) over the life of the project, but could just as easily be the internal rate of return. It shows that:

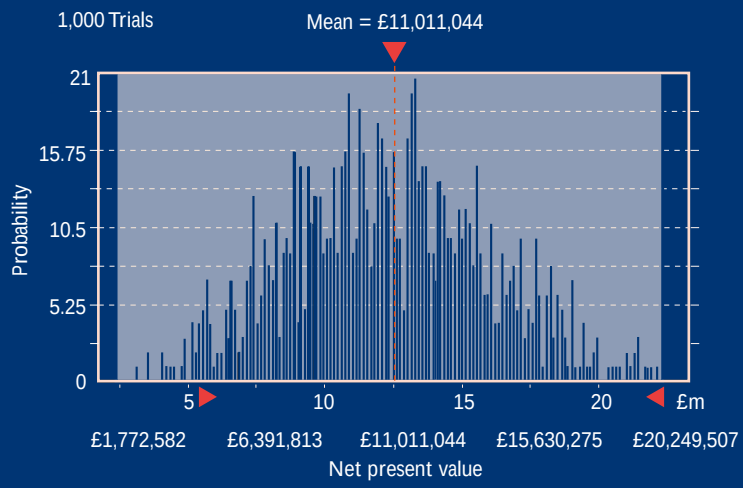
- the most likely outcome is a positive NPV of £11 million;
- the spread of outcomes with a 95% degree of certainty ranges from £4 million to £18 million. Hence the project is 95% certain to produce a positive NPV.

The questions to be asked using this chart are:

- How does the most likely return compare with the forecast prepared by the project sponsor? Is it more or less than expected, and why?
- Is the most likely return enough? How does it compare with the market norm, and with alternative investments? Could a different investment produce the same most likely return with a lower spread of risk, and the same upside potential?
- Are you dependent on the most likely outcome to fund other projects? What will you do if the lowest return is achieved? A prudent housing association might take the worst case scenario (i.e. lowest surplus) into its planning assumptions, and reinvest performance gains only when they are achieved.

Of course, you should also be asking if it is appropriate to place social housing

Diagram 2
Market rented project



Outcomes with a 95% degree of certainty range from £4.0m to £18.0m.

reserves at risk on a non-social housing project.

2 ***The chance to take over another company***

Sadly not all diversification projects produce a range of positive outcomes. The next example shows how simulation can be used to predict the likelihood of business failure. It is a real simulation of an organisation's business plan. The simulation looks at a range of outcomes and produces a probability distribution of what might happen. Diagram 3 indicates what is likely to happen, with a 95% degree of certainty. The main business of the organisation is non core to housing associations, with tight margins and a greater degree of price restriction than social housing.

The most interesting aspect of the graph in Diagram 3 is the comparison between what the organisation expects in its approved business plan (the top line) and what was most likely to happen. The question to ask yourself is 'would I make a long - term investment in this company?'

In short:

- the most likely outcome is an increasing deficit;
- the best you could expect (with a 95% degree of certainty) is a reducing surplus, and an increasing deficit just beyond the five-year horizon of the business plan;
- over time the 95% certainty band widens, and the project becomes more volatile;
- it is 95% certain that the organisation will not deliver its own business plan.

Under these circumstances a potential investor would have two choices:

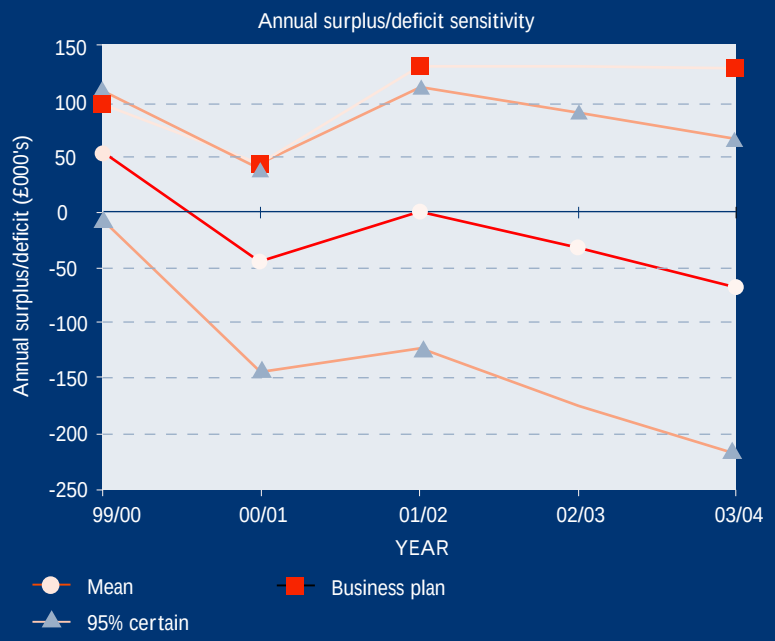
- continue, but get someone else to underwrite the loss;
- don't take off – if a plane has a 95% chance of crashing, it is little comfort to know that you are well insured!

This approach to simulation can be applied to new projects, potential mergers, new subsidiaries or your existing business. The example presents a compelling case for wider use of simulation techniques in the sector, especially among diverse social landlords.

3 ***A housing association's global financial model***

Finally, here is an example of how simulation can be used to test the likelihood of compliance with loan covenants in a social landlord's global

Diagram 3
Business plan simulation



financial model. Diagram 4 tests the ability of a parent association within a group to meet its covenants over a five-year period. Diagram 5 puts a fledgling subsidiary through the same test. In each case the Y axis represents interest cover.

The graphs demonstrate that:
- in the parent there is a 95% degree of certainty that covenant compliance will be achieved;
- in the new subsidiary there is far less certainty, with the prospect of *breach* falling within the 95% certainty band.

Using this information a social housing group can focus its resource on key risk areas, and develop a risk strategy appropriate to the circumstances of each group member. In the healthier parent the strategy might be full steam ahead, but with one eye on the dials. In the new subsidiary the strategy is likely to be more cautious, and could include:

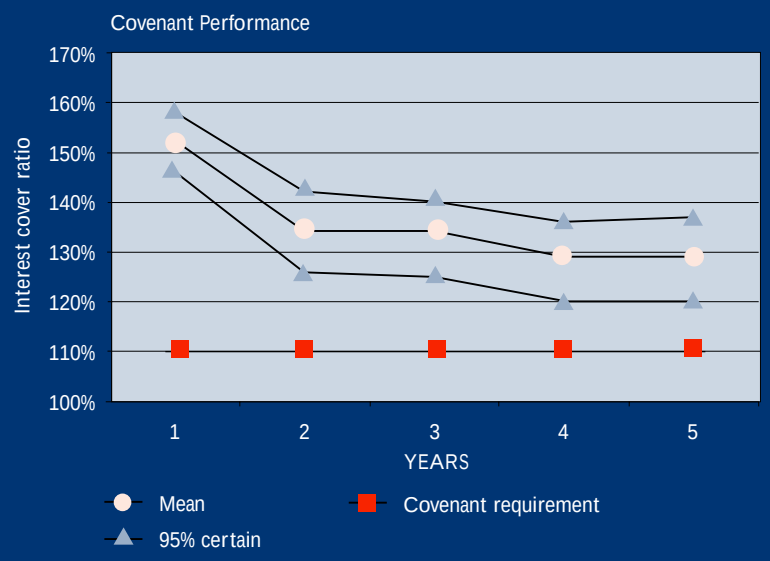
- identifying areas of flexibility within key income and expenditure areas (such as major repairs and property sales);
- separating expenditure budgets into essential and desirable, with desirables being held until the last quarter of each year;
- developing an early-warning indicator system to detect and prevent covenant breach;
- producing key indicators more often;
- focusing internal audit resources more on the subsidiary's control systems;
- liaising regularly with funders and regulators.

THAT'S ALL VERY INTERESTING, BUT THERE MUST BE LIMITATIONS?

Simulation brings another dimension to project appraisal. Allowing uncertainty into the forecasting process brings a better understanding of new and existing business and this enables more effective planning and risk management. But, like any planning and risk management tool, there are limitations.

The main limitation is that, like any other form of appraisal, it is only as good as

Diagram 4
Housing association global financial model: *Parent*



your assumptions. For this reason it is essential to publish the underlying assumptions checked back to an independent source where possible and subjected to challenge.
On larger and diverse projects, the range of outcomes and their dependencies should be scrutinised by an independent specialist to ensure they fall within market expectations.

Another limitation is that simulation is only as reliable as the model you are simulating. If the numbers don't add up in the underlying model, the simulation won't work.

Finally, simulation deals with financial risk. There are other risks, such as reputation risk, which cannot be assessed with the help of simulation. It is essential that these equally important risks are not neglected.

In other words, focus on the basics first, don't believe the graph just because it uses more advanced analysis tools, and don't forget the non-financial risks!

SIMULATION IN CONTEXT

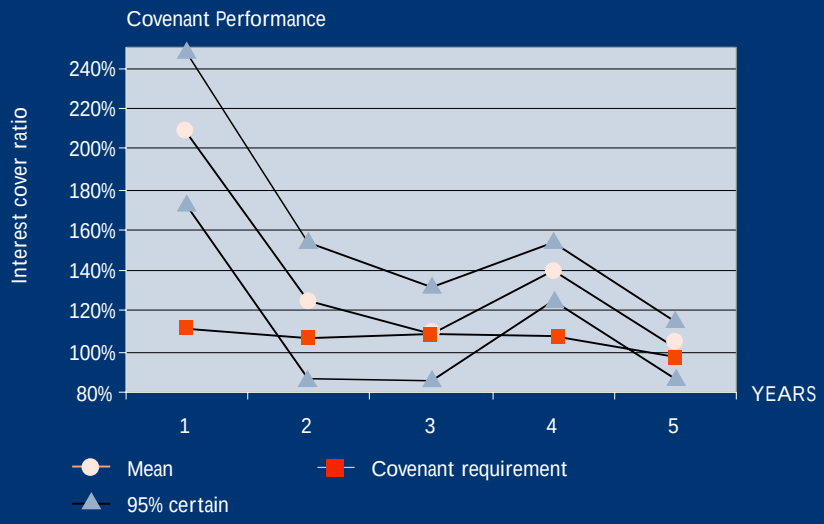
At London & Quadrant simulation is one of a number of tools used to manage risk. Our general approach is set out in our risk policy, which outlines how we manage risk, who is responsible, the risks we are prepared to take, and how much of each risk we will take.

At a strategic level risk identification is driven by the business planning process – which risk will we encounter pursuing our mission, what is the risk of our chosen course and what is the risk of an alternative course? At an operational level risk management is integrated into the process of continuous improvement – how can we improve processes and services, what is the risk involved, and are our controls appropriate?

By involving front-line staff in risk evaluation and control assessment we encourage ownership. This develops a risk-aware culture, and places us in a better position to manage the risks we never thought of as well as the ones we did!

So where does simulation fit in? Risk management is all about managing

Diagram 5
Housing association global financial model: *New subsidiary*



uncertainty, and simulation enables us to factor uncertainty into our plans. At the project appraisal level, all projects over a certain threshold are subjected to simulation, with the project sponsor setting the range of outcomes and dependencies. This helps us to assess the balance between risk and return, and to allocate an appropriate level of reserves to social housing projects.

At an organisational level, each member of the Group has its business plan subjected to simulation as part of the business planning process. This helps us to set internal risk buffers, to manage identified and unidentified risk, and to respond to opportunity.

COMING IN TO LAND

Simulation should not replace existing project appraisal tools, it should complement them. Sensitivity analysis enables you to understand the main risk areas, which helps you prioritise risk. At the end of the project appraisal process, you should approve a base case scenario and review variations from this scenario over time.

Simulation adds a further dimension by assessing how variables combine and compound over time to increase or decrease volatility. A better understanding of volatility helps with the allocation of financial and human resources and the production of appropriate, targeted risk management strategies.

Well, that's it. For those of you who chose to take the journey, I hope you enjoyed your flight, and that you will consider using simulation in your risk toolkit. For those who didn't, it's a long way to Monte Carlo on foot!

SUMMARY

Monte Carlo simulation is a risk management technique which helps businesses to manage uncertainty. It is used extensively by investment analysts and is now gaining in popularity in the social housing sector. By factoring uncertainty into our plans and projections, we can assess how financial variables combine and compound over time to increase or decrease volatility. A better understanding of volatility helps with the allocation of financial and human resources and the production of appropriate, targeted risk management strategies. It also helps to maximise financial and social return on our investment.

The Author

David Montague joined the finance team at London and Quadrant Housing Trust in 1988. He became Finance Director in 2000 and his responsibilities encompass the entire finance function of the Group including IT, treasury operations, business planning and risk management. The Group has a substantial development programme. David has played a key role in applying risk management techniques to the appraisal of the many development opportunities that are evaluated by the Group. He is a Fellow of the Association of Chartered Certified Accountants and writes and lectures on social housing issues.

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