Insights

Did we spot a black swan?
Stochastic modelling in wealth management

The use of financial economic models has come under significant scrutiny over the last 12 months in the wake of credit and equity market events experienced in 2008. In particular, some wealth managers have questioned whether their reliance on risk models could have resulted in flawed or unreliable advice due to a failure to account for the type of ‘extreme’ events experienced in 2008.

This report considers the performance of the Barrie & Hibbert stochastic model from the end of 2007, through the period of equity market turmoil during late-2008.

We provide results which demonstrate that the model had indeed assigned a reasonable probability weight to the events of 2008. In addition, we show that the ‘extreme’ events of 2008 had very limited impact on the assumptions within our model, and the associated distribution of asset return outcomes. This suggests that an advisor or wealth manager who had relied on a Barrie & Hibbert stochastic projection immediately before this period of equity market turmoil would have been strongly placed to justify financial planning decisions which had been based on the outputs from the model.

In addition, we provide a comparison of projections from the Barrie & Hibbert model with those based on assumptions used by another model provider. This illustrates the size of the difference in outputs and the impact on the wealth management process. In particular, we consider the practical implications for a wealth manager or advisor who may have used a model which did not capture the extreme events of 2008 to a reasonable extent.

We hope that this short report helps inform the debate regarding the application and performance of stochastic models within the wealth management process. In particular, we have demonstrated why stochastic modelling is indeed now an essential part of the wealth manager’s toolbox. Wealth managers and financial advisors should consider whether their existing financial planning tools and investment process include a stochastic model, and arm themselves with appropriate questions to test the reliability of these models.
Stochastic modelling - an essential tool for the wealth manager

A stochastic model allows us to generate possible scenarios for the future behaviour of economic variables and asset returns, and assign reasonable probabilities to each of these scenarios.

The objective or liability underlying most real-life financial planning problems is some future cash flow. The financial planning outcome for the client is the extent to which some chosen investment strategy or product is able to meet the objective. In most cases, this objective will depend not only on the total (cumulative) investment return over the investment term, but also, critically, on the sequence of those returns.

Consider a simple example of a 65 year-old with a fund of £100,000, invested in equities, from which he will draw a fixed retirement income of £9,000 per annum. An important question for the investor is the age at which the fund will run out.

The following table shows the age at which the will fund will run out, based on five different equity return scenarios. Although each of these return scenarios correspond to an average compounded return of +7% per annum, it is clear that the sequence of returns has a critical impact on the age at which the investor’s fund will become exhausted:

<table>
<thead>
<tr>
<th>Return Sequence</th>
<th>Age at Ruin</th>
<th>+/- Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant 7%</td>
<td>83.8</td>
<td></td>
</tr>
<tr>
<td>-7%, +8%, +22%,...</td>
<td>80.8</td>
<td>-36</td>
</tr>
<tr>
<td>+7%, -9%, +26%,...</td>
<td>81.6</td>
<td>-26</td>
</tr>
<tr>
<td>+28%, +7%, -11%,...</td>
<td>88.4</td>
<td>+56</td>
</tr>
<tr>
<td>-28%, +21%, +41%,...</td>
<td>76.1</td>
<td>-93</td>
</tr>
</tbody>
</table>

This simple example illustrates the importance of the sequence of returns risk to this investor. As a consequence, designing an appropriate product and investment portfolio must take into account the simple but important fact that a client can get the same annual average investment return from a portfolio, but get a radically different outcome.

Faced with this risk management problem, it has become increasingly clear to many wealth managers and financial advisors that deterministic product illustrations and financial planning tools do not capture the risks in their clients’ planning objectives. As a consequence, stochastic modelling has become an essential component of the financial planning toolbox for many wealth managers.

Did stochastic models capture the market events of 2008?

Given the increasing reliance on stochastic modelling tools within the retail and wealth management arena, a number of market participants have raised this quite reasonable question. In general, the primary concern expressed by wealth managers is whether information or recommendations they may have provided to clients based on outputs from stochastic models could have been ‘flawed’ or ‘unreliable’ in some respect, as a result of relying on a model which failed to capture the events of 2008.

In order to assess model ‘performance’ in the context of the financial planning process, we will consider three common applications of stochastic models:...
• **Decision support / What-if analysis**: Stochastic projection tools are used to compare the distribution of outcomes under different financial planning strategies. This could include comparing different products, portfolios, and/or different investment strategies. The objective here is to use the outputs from the stochastic projection to identify a financial planning strategy which best meets the client’s financial objectives and risk profile.

• **Illustration of risk**: The projected outcomes can be used by the financial planner to illustrate to the client the range of potential outcomes under the chosen financial planning strategy. This enables the client to confirm whether or not they are comfortable with the level of risk in the financial planning strategy proposed by the advisor. By involving the client in this way, the advisor can mitigate compliance or mis-selling risk.

• **Advice compliance audit**: Where the stochastic output has been used as an integral part of the planning and decision process (as above), these outputs can provide a record which enables the advisor to evidence an objective basis for the recommendation.

Based on an understanding of the above applications, we can describe two important criteria that we believe should characterise a ‘reliable’ or ‘robust’ stochastic model:

- The model should assign probabilities to extreme events that reasonably reflect the risk of such events occurring in the ‘real world’. Specifically, prior to 2008, the stochastic model should have assigned a reasonable probability to the actual market outcome observed during 2008 (or outcomes more extreme). Any model which ‘fails’ on this criteria is likely to have led to advisors or clients into believing the level of risk in a chosen investment strategy was lower than would have been reasonable, and would have led to potentially ‘wrong’ planning decisions. Furthermore, these clients would have experienced actual 2008 outcomes that may have been significantly worse than the ‘worst case’ illustrated by the model.

- When used to support medium to long-term financial planning (i.e. for investment terms of 5 years or more) the outcomes from a stochastic projection tool, and the decisions arising from the use of such a tool, should not be significantly impacted by short-term market ‘events’ such as those observed in 2008. Although some adjustment to short-term model parameters may be valid, the underlying (longer-term) economic assumptions within the model should not have changed significantly.

### 2008... Did we spot a black swan?

The first Exhibit on the left shows the distribution of percentile points for the change in £100,000 fund value over one year (from end-2007 to end-2008), for two alternative investment strategies:

- **Strategy A**: 80% Government Bonds; 20% Equity
- **Strategy B**: 40% Government Bonds; 60% Equity

These distributions reflect actual Barrie & Hibbert stochastic model projections for calendar year 2008, based on our assumptions from end-December 2007. On top of these forward-looking projections we have superimposed the actual 2008 outcomes, shown as dark blue squares. This shows that:

- The actual 2008 outcome for Strategy A fell close to the middle of the distribution projected at end-December 2007. This reflects reasonable bond returns observed during 2008.

- The actual 2008 outcome for Strategy B was above the lower 95% point of the distribution. At the end of 2007, the Barrie & Hibbert model assigned a probability of just over 5% (1 in 20) to an outcome at least as bad as that subsequently experienced during 2008.
Another way of interpreting this is that, at end-2007, our model assumed that an event as or more extreme as 2008 should be expected to happen on average about once every 20 years, or five times each century. This is confirmed by the second exhibit on the left, which compares the 1st and 5th percentile points of Barrie & Hibbert model projections for UK and Emerging Market equity returns over one year from end-2007 with three recent historic observations:

- FTSE All World UK: Jan 31 2002 – Jan 31 2003

Again, we can see that in these cases, the ‘extreme’ historic event falls within the 5%-95% range of the Barrie & Hibbert distribution at end-2007.

It is ultimately a matter of subjective judgement as to whether 5% (or 1 in 20) was a reasonable probability weighting to have assigned to an outcome as extreme as 2008. Certainly, we can look back at the history of the last hundred years or so and identify a handful of well-documented and similarly extreme market events. Equally, taking the views of industry experts, a number of respected economic commentators and central bankers have reflected that some of the problems facing the capital markets during 2008, and particularly constraints on credit and liquidity, were probably even more extreme than a ‘1 in 20’ event.

Our conclusion, in the context of how stochastic models are applied within the financial planning process, is that 5% (approx) was a reasonable probability weighting for our model to assign to this type of market outcome.

What was the impact of 2008 on model assumptions?

The second question that has been raised is: “How did the events of 2008 impact on your modelling assumptions?”

The exhibit on the left compares the distributions for the value of £100,000 invested in Strategy A (20% Equity) and Strategy B (60% Equity) over one year. The green bars show the distributions based on the Barrie & Hibbert model at end-2007, while the blue bars denote the distributions at end-2008.

There are two main points to note about the comparison of the end-2007 and end-2008 figures:

- The entire distribution of outcomes for both the 20% equity and 60% equity strategies has shifted down (see ‘A’). This is due to the fact that ‘risk-free’ cash and short-term government bond yields had fallen significantly during 2008. This has the effect of reducing the expected return on all asset classes across an economy by a similar extent, but has a very limited impact on risk (i.e. this affects the middle of the distributions to the same extent as the ‘tails’).
- The lower 95% and 99% points of the distribution of returns for Strategy B (60% Equity) have fallen slightly more than the other points in the distribution (see ‘B’). This is because, at the end of 2008, short-term equity market volatility (as evidenced by a number of measures including implied volatility information embedded in traded option prices) was significantly higher than the long-term average. This market feature was captured in the spread of returns modelled over terms of up to 1-2 years. This effect disappears if we consider returns projected over longer terms (e.g. 5 years).

The conclusion we can draw from this analysis is that whilst the equity market turmoil of late 2008 had some modest impact on the spread of equity returns projected over very short horizons, the assumptions used to project investment returns over horizons of more than 1 year were largely unaffected by the equity market events of 2008. We believe this is a desirable feature of a model that is to be used for medium to long-term financial planning or wealth management purposes.
Are all models the same?

In practice, it can be very hard to go back and evidence exactly what assumptions other model providers were using at the end of 2007, during the period immediately before the unusually high market volatility of late 2008.

However, to provide a reasonable guide to the potential scale of the differences in assumptions and outputs between different models, we have referred to recent data published by another provider, whose stochastic model is also used in the retail wealth management sector. The outputs published for the other model were for the distribution of UK and Emerging Market equity returns over one year from end-2008. No information was provided regarding the nature of these distributions at end-2007.

This analysis is intended to provide a guide to the potential variance between the outputs of different models. Since we are unable to access details regarding the underlying structure of the model or calibration methodology, we have not attempted to replicate specific financial planning outputs from particular financial planning tools.

The chart on the left of this page compares the distribution of UK and Emerging market equity returns from the Barrie & Hibbert model (green) with those published by the alternative model provider (red). The outer edges of the light and dark shaded areas of the bars denote the upper and lower 1% and 5% points of the projected return distributions. The median outcome is shown by the black squares.

On top of the projected equity return distributions from the two models, we have superimposed some actual historic observations:


The difference between the one-year equity return distributions from the two models is stark:

- Firstly, it is clear that the ‘worst case’ outcomes are very much lower under the Barrie & Hibbert model than the alternative model. The Barrie & Hibbert model suggests there is around a 1 in 20 chance of a fall of 30-35% in UK equities, while the alternative model assigns a similar probability to a 15% fall.
- Secondly, the Barrie & Hibbert model appears to assign a probability of around 5% to an equity market fall of a similar scale to 2008 occurring over the next year. Although it is not possible to tell precisely from the published information, the alternative model appears to assign a very much lower probability to such an event.

Although this comparison is based on end-2008 numbers (we have no information on the assumptions used by the other model at end-2007), it would be reasonable to conclude that had the end-2007 assumptions been broadly similar to those at end-2008, then advisors relying on the alternative model would have assumed the risk of a 28% fall in UK equities was more or less negligible, and that a 15% fall was a reasonable ‘worst case’ outcome. Financial planners who had made investment recommendations based on such assumptions may now be faced with some very difficult questions from clients holding equity portfolios which have lost much more than 15% of their value.

The model matters!

From the previous section, we can conclude that some other stochastic model providers may have assigned a very much lower probability to the equity returns of 2008 than Barrie & Hibbert.

This fact in itself suggests that wealth managers and financial advisors should be asking their stochastic model providers for more detailed information regarding model structure, calibration methodology and model outputs.

However, to put this in sharper context, it is also very important to consider the likely practical implications for a wealth manager of using models with such different assumptions...
An unrealistic model will lead to unsuitable advice

As an example, take a client who was approaching retirement at end-2007 and wanted to buy an unsecured retirement income product that allowed continued access to capital. This client would have been faced with a choice between a range of different products, including different asset allocations and features such as income and death benefit guarantees. If the advisor had relied on a model that significantly underestimated the level of risk, then they may have recommended an asset allocation with a much higher equity exposure than their client was willing or able to accept. Conversely, they would also have assigned a much lower value to a product with a guarantee.

The choice of model could alter the decision as to which product and/or investment strategy was most suitable for the client.

An unrealistic model will undermine the advice audit trail and advisor credibility

As described earlier, the advisor may use the stochastic model to illustrate the range of potential outcomes under a recommended product or strategy. This enables the client to confirm whether or not they are comfortable with the level of risk, given the recommendation proposed by the advisor. By presenting risk explicitly to the client in terms of a ‘worst case’ outcome, the advisor can maintain an audit trail to evidence that the advice was aligned with the client’s risk profile.

However, would this audit trail bear scrutiny if the advisor had provided the client with an illustration based on a stochastic model which significantly underestimated the probability of an equity return outcome such as 2008?

Suppose the retirement customer described above had originally selected an unsecured pension drawdown product with a high equity allocation. The advisor had supported this recommendation with an illustration which showed how much the retirement income level could fall during retirement under a ‘worst case’ outcome for investment returns.

Now roll forward one year, to the end-2008. Concerned that his retirement plans may have been adversely impacted by the poor market performance during 2008, the client asks his advisor to review the status of his retirement plan. The advisor uses the same stochastic model to review the client’s current position and finds that the ‘worst case’ income scenario has fallen significantly from that presented to the client one year earlier, when the original recommendation was made. This is a result that the client would find hard to accept and that the advisor would find very hard to justify.

Conclusions

Most financial planning problems faced by wealth managers are path dependent, being exposed to sequence of returns risk. To provide reliable advice requires a stochastic approach to financial planning. Therefore, it is of critical importance that stochastic models used by wealth managers and financial advisors provide a robust basis for modelling risk.

We believe there are three key characteristics of a reliable model:

- The model should incorporate all the important risk factors which have an impact on the client’s financial planning objective. Interest rate risk, inflation risk, credit risk as well as equity market risk should all be captured within the model.
- The model should generate scenarios that reflect the full range of possible ‘extreme’ outcomes that could reasonably be expected in the real world. For example, the model should capture the fact that very large (positive and negative) equity market returns are observed more frequently than would be implied by a conventional log-Normal model.
- The model should assign a reasonable probability to these more extreme scenarios. This requires the stochastic model to be calibrated effectively, based on historic market data, current prices and an expert understanding of the fundamental relationships driving the future behaviour of the various economic risk factors.
Specifically, in relation to the events of 2008, we have considered two important questions which we believe should be used to test the reliability or robustness of a stochastic model:

- Based on the model assumptions and associated outputs at end-2007, did the model assign a reasonable probability to the equity market returns of 2008?

  The Barrie & Hibbert model assigned roughly a 5% (1 in 20) probability to the equity market event of 2008. We believe this was a reasonable probability weighting for our model to assign to this market outcome.

- Were the modelling assumptions and the associated projected outcomes, significantly impacted by the market events of 2008?

  Where the Barrie & Hibbert model has been used for medium to long-term retail financial planning purposes, the assumptions used to project investment returns were largely unaffected by the equity market events of 2008. We believe this is a reasonable characteristic of a reliable risk model for medium-long term financial planning.

In this report, we have demonstrated that the Barrie & Hibbert model would have provided a reliable basis for modelling risk in wealth management and financial planning applications prior to the market turmoil of 2008.

Given the increasing reliance on stochastic modelling tools in the wealth management process, we would suggest that wealth managers and advisors should expect providers to evidence the reliability of their models. These tests of reliability should be based on a detailed and explicit statement of model assumptions and outputs and a comparison with actual market events.
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