Guy Debelle: On risk and uncertainty

Address by Mr Guy Debelle, Assistant Governor of the Reserve Bank of Australia, at the Risk Australia Conference, Sydney, 31 August 2010.

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"*The future's uncertain and the end is always near*" – Jim Morrison

Today I want to talk about the role of risk and uncertainty in the financial crisis. The primary reason why I want to do that is that I believe risk assessment, or more precisely, mis-assessment has been one of the key elements of the crisis. While that is undoubtedly true in any crisis, I think it has played a more central role in the current episode than in the past.

Risk was mis-assessed by financial institutions, risk managers, investors and regulators. There was a false comfort taken from a misplaced belief that risk was being accurately and appropriately measured. To some extent, the technology provided risk managers with a false sense of security. Risk may well have been accurately measured for the particular regime that the economy and financial markets were operating in. But the risk assessment was not robust to a regime change that took the models out of their historical comfort zone. Not enough account was taken of uncertainty.

One of the messages I want to leave you with is that risk measurement based on historical models can only take you so far. Judgement must play an important role. Ultimately, the future is uncertain, in the sense that it cannot be quantified. The goal should be to design systems that are as robust as possible to this uncertainty. A system with less leverage is one obvious means of enhancing robustness.

Risk versus uncertainty

In discussing risk, I would like to highlight the key distinction between risk and uncertainty: risk is quantifiable, uncertainty is not.

This is a distinction with a long tradition. Keynes made much of it,[1] as did Frank Knight who lends his name to "Knightian" uncertainty, on which he elaborated in *Risk, Uncertainty and Profit* in 1921.[2] Knightian uncertainty arises when you don't know the underlying probability distribution, which makes quantifying the risks impossible.

More recently, this distinction has been given prominence by Donald Rumsfeld with his knowns and unknowns, as well as by Satyajit Das in *Traders, Guns and Money* and Nassim Taleb in *The Black Swan*.

In addition to the distinction between risk and uncertainty in terms of measurability, Keynes made the similar distinction between cardinal and ordinal probability. Indeed his *Treatise on Probability* has this as one of its central concepts. Cardinal probability is quantifiable: the probability of heads in a coin flip is 50 per cent. Ordinal probability is qualitative: for example, (as much as it pains me to say it), Collingwood are more likely to win the premiership this year than Carlton. How much more likely they are to win, I couldn't tell you exactly. Model-based risk management handles cardinal probability a lot better than ordinal probability.

In the period prior to the onset of the crisis, hubris developed in parts of the financial sector, and in the investor community more generally, that everything could be precisely measured and priced. In particular, that risk was always quantifiable. To some extent, in the narrow

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[1] See Skidelsky's discussion in *Keynes, The Return of the Master*.

[2] See Cagliarini and Heath (2000) on the effect of Knightian uncertainty on monetary policy.

sense, that is correct because, as just described, I see measurability as the key distinction between risk and uncertainty. But risk assessment needs to take account of both risk and uncertainty.

I am not saying that the quest for improved measurability was misplaced. There was a lot of progress made in better understanding the way financial markets operate and enhancing the technology of risk assessment. The problem was that the management of risk proved to be too narrow. The focus tended to be on things that were quantifiable (cardinal probabilities) to the exclusion of those which were not. Some risks were treated as cardinal even though they were actually ordinal. Some risks, such as liquidity risk and roll-over risk were neglected.

Moreover, the risk assessment was often based on too short a history that did not include a set of observations relevant to the events that were unfolding. Comfort was taken in the precision of the measurement without thinking enough beyond the measurement. That is, not enough judgement was exercised. Indeed, it seems to have often been turned off.

A key question to ask is: could it have included a relevant set of observations, or were the events of the past three years unpredictable, too uncertain? That is a question I will come back to shortly.

I don't want to get too Rumsfeldian here, but an important element of risk management is to know what you don't know.[3] (Although Mark Twain might beg to differ: "It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.") But unfortunately even that is not good enough. From a risk point of view, ultimately you need to be able to measure what you don't know. That, I believe, is inherently impossible.

Because it is impossible, we should make society as robust as possible to uncertainty, while realising that it is not possible to insulate it completely from uncertainty. I do not believe that "the Truth is out there" waiting to be discovered. The Quant faction in financial markets, to some extent, is on a quest to find "the Truth", the data-generating process that is at the root of financial markets.[4] While a valiant quest, with much knowledge to be gained in its pursuit, like Lancelot's quest for the Holy Grail, it is likely to be in vain. (This is of course, itself, a qualitatively probabilistic statement about an uncertain event!)

A critical issue is: how important is all of this? The answer is that it depends on the circumstances. In the good times, not being able to quantify the risk of the unknowable downside, or take into account the uncertainties, is not that important while ever the good times last. Indeed, there is little to be gained from doing so. Every once in a while, however, it becomes the main game.

The "Great Moderation" of the 1990s and 2000s lulled investors and risk managers into a false sense of security. The decline in volatility led many to conclude that a new, more stable, regime had been established. Let me make it clear that I am not saying that the stable macroeconomic environment of this period was a bad thing. Far from it. The improvement in welfare generated by the low unemployment rates, stable growth and low inflation was large and welcome. I do not subscribe to the somewhat Austrian view that the stability and decline in volatility sowed the seeds of its own destruction.

Models could do a good job of measuring what was taking place during the Great Moderation. The models were also doing a good job of out-of-sample prediction because the future was unfolding broadly in line with the samples used to estimate the models. When shocks occurred, they were still consistent with the error distribution that underpinned the models and hence provided further validation to the models. Models were continually refined,

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[3] Actually, to give credit where credit is due, this should be attributable to Confucius, and then Thoreau, before we get to Rumsfeld.

[4] See Scott Patterson's *The Quants*.

but this was not too difficult. They may have become more complex, taking advantage of the improvement in computing power to analyse price movements and discrepancies at a higher and higher frequency. But the underlying data were still assumed to come from the one stable Data Generating Process.

The problem came when the future unfolded in a way that was no longer consistent with the history used to develop these models. This raises the question of whether things would have been different if a more appropriate history had been used in the estimation, or is that simply a pipedream?

What is the right history? Is it different this time?

This time is different. As Reinhart and Rogoff point out, this is the excuse which is always used when there is a major shock to the status quo. However, a careful reading of Reinhart and Rogoff shows that while the general themes often repeat themselves, unfortunately history doesn't repeat exactly.[5] Things are different enough to matter. History can inform, but ultimately it is only a guide. History is not a forecast.

History plays a prominent role in risk assessment. History shapes the models used as well as the data underpinning them. But what is the relevant history that should be taken into account in the risk assessment?

I will answer this question using value-at-risk (VaR) models as an example. I am not meaning to single these out (although I do have some particular misgivings about VaR and its application), as the same issues arise with all models.

VaR models draw observations from a defined period of time which is generally not all that long. As observations are realised, the model is further refined. If observations start to be realised which lie outside the distribution of the VaR, it is updated to take account of that, imparting a procyclicality to the process. If the short time period used to estimate the model is an unrepresentative guide to what is about to unfold, then VaR has a serious problem.

But in an era of reduced volatility like the Great Moderation, the shortness of the time period was not so much the issue. Indeed a longer data sample would still have generated similar outcomes, as long as it lay within the period of the Great Moderation. Rather the problem was the misplaced expectation that volatility was permanently reduced. This was then combined with the belief that the distinction between uncertainty and risk was no longer particularly relevant. That is, the belief was that while the future was still unknowable, it was still likely to lie within the distribution of the recent past. This was believed to be so because there supposedly had been a regime change which meant that the earlier, more volatile, period of history was no longer relevant.

But how much history should be relevant? That is a difficult question to answer, although it a question which should always be asked.

When one is looking at financial market pricing, should one include observations from the 1920s, when the structure of financial markets were markedly different? Or when the policy reaction function today is completely different to that in the 1920s? In that regard, it is interesting to read *Lords of Finance* and gain an insight into the mindset of the policy makers at the time. We would like to think we have learned from that history and hence that the policy responses today have been conditioned by those lessons.[6] Given that, the 1920s may

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5   I recall this point often being made by the late Rudi Dornbusch, of whom Rogoff was a student.

6   One could argue that given the Germans experienced hyperinflation and the Americans, the Great Depression, the lessons policy makers in those two countries have drawn may be somewhat different.

not be relevant to model estimation today because there has been a major structural change. So perhaps history can be too long, as well as too short.

To use another example, if one is assessing the distribution of possible outcomes for Brazilian interest rates, should one include observations from the periods of hyperinflation? It would seem a more reasonable assumption that there has been a regime shift and hence that earlier period is no longer relevant.

Similar arguments can be brought to bear on stress tests, which can be used to assess the robustness of a model, or a risk management regime, to a set of outcomes that lie outside the data history of the model. Stress testing can go beyond out-of-sample forecasting in that one can conceive of a scenario which is not completely model-consistent. Nevertheless, a similar question can be asked: what is the universe of events that should be considered? To take an extreme, should I stress test my model against the prospect of nuclear Armageddon. It would seem extreme to do so now, but maybe in the 1950s it wouldn't have been perceived as such a tail event.

To take perhaps a more relevant recent example: in the US, financial institutions, credit rating agencies and investors stress tested their mortgage portfolios and mortgage-backed securities. However, the stress test was derived from the history of house prices in the US. That history suggested that cities in the US had their own price cycles and that the correlations across markets were not particularly strong. Periods of large house price decline were confined to a few idiosyncratic events in a few cities. One could obviously have stressed the mortgages assuming some moderate nationwide house price decline.[7] And indeed a number of the AAA-rated securities would not have maintained their rating under that scenario. But given the history prior to 2007, would a stress test of a nationwide 20 per cent decline in house prices have been considered plausible?

To illustrate this point one last time, consider Bear Stearns. With the benefit of hindsight, it would seem sensible that Bear should have stress tested their funding resilience to a significant reduction in funding from the repo market. But how significant a reduction should have been stressed? A 10 per cent reduction, a 50 per cent reduction or a complete closure of the repo market?[8]

In the event, the latter was obviously what occurred. But there had not been such an event in that market before, so it may well have been difficult to have even conceived of it or believed it to be a plausible stress. In terms of risk assessment, one could only have expressed it qualitatively not quantitatively. I could have told you that a closure of the repo market was an extremely unlikely event, but I could not have assigned a probability to it. For a stress test, the ability to only assign an ordinal rather than a cardinal probability is not necessarily a problem, but it is a problem in then assessing the market value of financial instruments issued by Bear, or determining the appropriate risk mitigation strategy that Bear should have adopted.

However, post-Bear, a complete closure of the repo market to a particular institution is now a conceivable event, and maybe I could even begin to assign a cardinal probability to it. And to some extent the market did in its re-pricing of CDS premia of various financial institutions. But from a stress test point of view, it would appear that Lehman Brothers did not adequately factor this event into its set of scenarios.

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7   There is the possibly apocryphal story recounted in Michael Lewis' "The Big Short" that a house price model used by a rating agency could not accept a negative number.

8   See William Cohan (2009) for a detailed account of the effect of the closure of the repo market on Bear Stearns.

Now, having seen that history, banks stress test their resilience to a closure of short-term funding markets, because it is an event that is in the recent experience. But what heretofore unconceived event will they be vulnerable to in the future?

The answer, of course, is that is impossible to tell. So an important part of the solution from a regulatory point of view is to make the system as robust as possible to such events. Obviously one cannot make the system impregnable, nor would it be optimal to do so. So let me now turn to some issues surrounding the design of a system that can be more robust to uncertainty.

Towards a robust system

A primary step in making the system more robust is to be using the right models. Using a number of models at the same time is probably going to be helpful too. But the point I have been trying to make is that while that is a commendable objective, what is right in one set of circumstances may not be right in another. A healthy dose of judgement needs to be added to the model-based analysis. We might be comfortable in having an overall framework that is robust to these changes in circumstance, but it may well not be possible to distil that framework down to a set of quantifiable models that can be useful in practice.

Hence the aim is to make the system robust, whatever the right model. As my colleague at the Bank of England, Andy Haldane, has highlighted, leverage is a critical factor in making the financial system less robust to uncertainty.[9] Andy shows that leverage played the major role in translating events which would have been somewhat damaging, but survivable, into events which were fatal. Leverage increases the returns to bets which pay off, but simultaneously increases the losses from bets that do not.

Financial institutions had (by and large) made the assessment that the leverage that they were carrying was not fatal. Their models told them that it was not, unless there were draws from the extreme tails of the model's distribution. Unfortunately, as David Viniar, CFO of Goldman Sachs, put it, we were "seeing things that were 25 standard deviation moves, several days in a row". He said this in August 2007. The tails continued to get fatter and fatter for at least the next year.

The light-touch regulatory approach applied in some jurisdictions (although not in Australia) also unfortunately assumed that the models were doing an adequate job. At this point, the Efficient Markets Hypothesis (EMH) is generally dragged out and beaten. But I think that is somewhat of a straw man. The main message I take from the EMH is that there are no gains left on the table, not that (financial) economics had reached a bliss point where the world could be fully encapsulated by a utility-maximising representative-agent model.

The goal of making the financial system more robust to uncertainty is one of the key motivations behind the reforms being finalised in Basel at the moment. It is worthwhile to note that the Basel reforms are primarily focussed at the institutional level. That is, the idea is to help make the system robust to an idiosyncratic institutional shock (although measures addressing the system as a whole are also being considered). This includes measures designed to limit the leverage of financial institutions, deliver a more robust funding structure and enhance their capital buffers.

While these measures work to increase the robustness at an institutional level, in the event of a system-wide event, such as took place in 2008, a different set of considerations come into play. Once a systemic shock of that nature occurs, it requires a systemic response, which ultimately must come from the public sector, including the central bank, which has the capacity to respond. The institutional framework determines the point at which the public

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[9]   See Haldane (2009a,b).

sector needs to be called on. But in terms of insurance of the system as a whole, at some point, it has to be provided by the public sector.

I do not believe it is socially optimal for the individual entity to fully insure itself. It would be excessively costly for the financial sector to hold enough capital and liquidity to enable it to survive a freezing of capital markets of the type that occurred in 2008. At some point, it is not even affordable. As Ricardo Caballero puts it, the presence of "Knightian uncertainty [means] that scarce capital is wasted insuring against impossible events".[10]

Financial services are a key intermediary input into the production process. A severe curtailment of those services has a material impact on the capital accumulation process, unemployment and the long-run growth prospects of the economy. It is in the interests of society to ensure that the public sector provides a backstop in such circumstances to mitigate the externality caused by the individually rational risk-aversion of financial sector participants.

Finally, the financial innovation of the decade or so prior to 2007 saw the development of a large number of derivative products whose goal was to disperse risk around the financial system. This was done, in part, to enhance the robustness of the system to any idiosyncratic shock and to ensure that the core process of financial intermediation was not significantly compromised when the shock hit. This worked up to a point, in that the situation, as bad as it was, may have been even worse if all the losses resided on the books of financial intermediaries rather than also on the books of pension funds etc, where the immediate effect of the losses was diffused somewhat (although less of it turned out to be diffused than originally thought). Whether this is true or not will be an interesting research question in the years ahead.

Conclusion

The argument I have been seeking to make today is that the mis-assessment of risk has been a key element of the financial crisis. One of the contributing factors to this mis-assessment was an over-reliance on a model-based approach to risk management, which focussed too much on measurable risk without taking full enough account of unmeasurable uncertainty.

Taking account of uncertainty is not easy, after all, it is uncertain! But at least a focus on ordinal as well as cardinal probabilities, in part by stress testing with scenarios that fall outside the model's history, would surely be beneficial. But stress testing and the assessment of uncertainty is still constrained by the difficult decision as to what is the relevant set of stresses that the framework should be subjected and what is the relevant history. A healthy dose of judgement needs to be brought to bear on these decisions.

Given these difficulties, it is important to try to make the system as robust as possible to the inherent irreducible uncertainty. One key element of this is restraining leverage, which can limit the number of illnesses that turn into fatalities.

Bibliography

Ahamed L (2009), *Lords of Finance: The Bankers who Broke the World*, Penguin, New York.

Caballero RJ (2010), "Crisis and Reform: Managing Systemic Risk", XI Angelo Costa Lecture, Rome, 23 March.

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[10] See Caballero (2010).

Cagliarini A and A Heath (2000), Monetary Policy in the Presence of Knightian Uncertainty, RBA Research Discussion Paper 2000-10.

Cohan WD (2009), *House of Cards: How Wall Street's Gamblers Broke Capitalism*, Allen Lane, Great Britain.

Das S (2006), *Traders Guns & Money: Knowns and Unknowns in the Dazzling World of Derivatives,* Prentice Hall, Great Britain.

Haldane AG (2009a), "Small Lessons from a Big Crisis", Remarks at the Federal Reserve Bank of Chicago 45th Annual Conference "Reforming Financial Regulation", 8 May.

Haldane AG (2009b), "Why Banks Failed the Stress Test", speech given at the Marcus-Evans Conference on Stress-Testing, 13 February.

Lewis M (2010), *The Big Short: Inside the Doomsday Machine*, W.W. Norton & Company, Inc, New York.

Patterson S (2010), *The Quants: How a New Breed of Maths Whizzes Conquered Wall Street and Nearly Destroyed It*, Crown Business, New York.

Reinhart CM and K Rogoff (2009), *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press, Princeton.

Skidelsky RJA (2009), *Keynes: The Return of the Master*, Allen Lane, United Kingdom.

Taleb NN (2007), The Black Swan: The Impact of the Highly Improbable, Random House, New York.