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GIRO Convention

23-26 September 2008
Hilton Sorrento Palace

Actuarial Models and the Real World

David Sanders

The Perfect Storm

- Stock Market in Meltdown
- AIG rescued
- Hurricanes hitting US
- Reloading of capital more difficult
- The $Trillion Black Hole
- Welcome to the Real World
- What about Solvency II?

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Hank Greenberg

- Concerned that catastrophe losses would erode the capital of AIG
- 50 years of work ruined by a major quake
- Wrong Cat
- Lost $3.3bn

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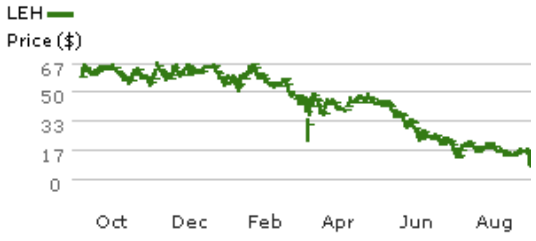
The Lehman slide



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Greenspan

- Once in a century event
- Once in 50 year event
- Once in 75 year event
- If he is right it is NOT the Black Swan
- It should have been considered in all Capital assessments

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AIG

- Rating agencies downgrade debt
- Needed to put up collataral
- Underwrote non insurance risks
- The same issues as in Mortgage Default Market in UK
- Are there more out there?
- What were the odds at the beginning of the year that AIG would be bust ?

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Warren Buffet

- 2002 – Derivatives are time bombs
- Financial weapons of mass destruction
- Buying stake in Goldman Sachs

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US Bail Out

- AIG Bail out
- Fannie Mae and Freddie Mac bail out
- $trillion bail out – but not certain
- Is this Equitas 2?
- Bail out to include insurance companies
- FBI investigating fraud in above plus Lehman
- Fear of bottomless pit

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Welcome to the Real world

- Where are the regulators?
- It's not a 1 in 200 year event!
- Useful to analyse what we do to ensure that we understand our shortfalls in the models we use
- In the case of banking this appears not to a have been appreciated

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A poem

Non domandarci la formula che mondi possa apiriti
Si' qualche storta sillabak e seccha come un ramo
Codestu solo oggi possiam dirti
Cio' che *non* siamo, cio' che *non* voglioma

Eugenio Montale
Ossi di Seppia (1923)

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A poem

Don't ask us for the formula capable of unlocking worlds for you
Like a crooked syllable and as dry as a branch
Only this we can tell you today:
That which we are not, that which we do not want

Eugenio Montale
Ossi di Seppia (1923)

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First Crisis- 1975

- FTSE at 100
- Money not available for reloading capital base
- Inflation at 20%
- Three day working week
- Beer 20p a pint

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Black Monday (or Friday) and Others

- Storm 87 J
- Stock market crashes
- 1990's Mortgage default
- Dot Com
- LTCM
- Equitable Life
- Conclusion – financial crisis is much more common than you think

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How do we fit in?

- We have significant experience in this
- It is a combination of the LMX spiral and mortgage guarantee ..all from the late 1980's (those of us old enough to remember)
- Indeed I discussed this over a year and a half ago with academics
- My rough estimate then was a cost of $250 billion - $500 billion (excluding insurance)

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Black Hole or Not and should we worry

- Two weeks, we had the opening of the Large Hadron Collider at CERN
- A load of excitement re Black Holes
- Stephen Hawking, the Lucasian Professor of Mathematics at the University of Cambridge was a very useful fellow to have around, patiently explaining that the black holes were only very small and that we really shouldn't worry ourselves.
- With the collapse of Lehman Brothers and the US Government's bailout of AIG and the US banking system where's Professor Stephen Hawking when you need him?

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Black Hole or Not- Public peceptions

- The global financial crisis is swallowing up banks, insurance giants, pensions
- There are a host of financial instruments that no one would recognise if they popped up on the next desk,
- The public need some reassuring person to explain what's going on and tell us that it's all going to be all right.
- We are having a crisis where the man in the street doesn't have the foggiest idea what it's all about.
- There perception is that people took enormous bonuses and we are now paying for it – Greed is the key
- We have impending collapse of the world's banking system. It certainly matches the CERN story for brain-numbing complexity.
- People are asking
  - What is short-selling**?**
  - **Who thought it was a good idea to give mortgages to people who were never going to pay them back?**
  - **If Lehman has lost billions of dollars, where has the money gone?**

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Readers Comments on Sciam article on Fractiles explaining everything happening in the Stock Market

- We have criminals in charge and they ran a pyramid scam on the American people disguised as a real estate "boom". You don't need a complicated mathematical model to predict how a pyramid scam will end, unless you're stupid.
- The power of every theory is in its prediction and our ability to act on this prediction. i. schagaev
- Fractals do not help in any sense to predict the likelihood of market behaviour.

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The Methodology of Actuarial Science by J M Pemberton

- *Actuarial science is concerned with the development of models which approximate the behaviour of reality and have a degree of predictive power, not the truth.*
- *Simple laws do not adequately describe complex realities*
- *Actuarial science deals directly with low-level generalizations, recognizing the limited nature of available regularities*
- *Models, by their very nature, are simplified representations of reality.*
- *They rely on estimated measures of the probability of future contingent events. Even the best model cannot predict a future contingent event will occur with 100% certainty or guarantee a specific outcome*."

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Jim Stannard - ASTIN

- The model needs to be effective,
- Defined as producing reasonably unbiased estimate for the decision needed,
- Being clear about key assumptions and what the effect of changing those assumptions is on the estimate
- Having inner workings of model that are understood by the decision maker
- The output is well organized and the result is produced within the timeframe that the decision is needed.
- The key barriers to achieving this are difficulties in the organisation and an over complex model

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Decision Making

- Most of our decision processes are evolutionary in nature.
- Suppose we are in a jungle which has predators in it.
- We hear a rustling in the bushes. We can either run away or explore the situation. If we run away every time we hear a rustle we may miss opportunities for gathering food and mating. If we over analyse we may ourselves become food. Thus we have evolved to have a basic instinct (or gut feeling) for the "correct" action given the information

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Decision Making - Underwriter

- A risk is offered to a company.
- The underwriter will often review the risk, using a number of basic criteria such as "Why am I being presented with this risk", "Is it something I've seen earlier", "Am I exceeding my exposure" and so on.
- He will therefore have a gut reaction as to whether he wants the risk and then the price.
- Often the price is determined by a lead underwriter.

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Decision Making Actuary

- Now consider the actuary.
- He will ask for lots of data, fit a Gamma (or other appropriate distribution), fit a complex model
- Run simulations and so on to come up with an alternative price.
- In an evolutionary concept the underwriter may be considered a winner as it is very similar to the decision process described above, while the actuary gets eaten! However the actuary has the advantage of having a model he can formulate and explain; assuming the underwriter can understand him.

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The Problem with Basel

- The bottom up approach has failed
- Get a distribution and look for 99.5th percentile is not good enough
- Need to start at real extreme events and work downward
- Do we need to work on gut analysis rather than in deep actuarial models- particularly in the time scales involved

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The Problem with Basel

- The assessment of risk was undertaken by the quants using complex models. These models appear to have ignored many contingencies, particularly the possibility of a subprime issue, although similar issues were in the historic data
- Management did not understand what the quants were doing yet relied on them almost entirely. Communication appears to have been limited.
- The regulator appeared to believe everything was fine, because they were told so by the management

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Banking Regulation

- Banks originally borrowed at 3 per cent and lent at 6 per cent and made a healthy living.
- Then they discovered trading in securities. As a consequence banks could offer a range of products with risks significantly different from those they traditionally run.
- There was also the introduction of relationship banking; the transactions reflected an implicit commitment that the bank would not walk away if the customer got into trouble.
- On the negative side there were a number of losses to financial institutions, the classic example being Barings.
- The regulators took notice, as the repercussions of bank failures can be devastating and have repercussions on the whole economy. Banks must be seen to be solvent.
- The simple rules of capital as a percentage of loans were no longer viable, and so Value at Risk was introduced

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VAR

- Wikipeadia defines **Value at Risk (VaR)** is the maximum loss not exceeded with a given probability defined as the confidence level, over a given period of time
- However VaR does not give any information about the severity of loss by which it is exceeded.
- Other shortfalls include the lack of subadditivity. That is, it's possible to construct two portfolios, A and B, in such a way that VaR (A + B) > VaR(A) + VaR(B).
- This is unexpected because we'd hope that portfolio diversification would reduce risk.

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VAR is a charlatan (Nassim Taleb)

- Measuring probabilities of rare events requires study of vast amounts of data. For example, the probability of an event that occurs once a year can be studied by taking 4-5 years of data.
- High risk-low probability events like natural calamities, epidemics and economic disasters (like the Crash of 1929) are once a century events which require at least 2-3 centuries of data for validating hypotheses.
- Since such data does not exist in the first place, it is argued, calculating risk with any accuracy is not possible.
- In the derivation of VaR normal distributions are assumed wherever the frequency of events is uncertain

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VAR over what time period

- In banks the time period is short, because (in theory) they can liquidate the position in days. The percentage used was between 90% and 99%. The reason for this was these are numbers one can readily relate to (whats a 9 between friends!)
- The regulator then stepped in. The calculations gave nowhere near the then current level of capital.
- So the question was whether to increase the percentage to 99.95% (whatever that means), or have 99.5% with a fudge factor.
- Risks were extended from market to credit , liquidity and operational risk Percentiiles were enshrined in legislation.
- Most senior management didn't have a clue how they were calculated or what they really meant.

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Risk and Uncertainty

- Assume the probability of a loss of a cargo was 25%, and value of a cargo of £1,000.
- It would be equally risky to put the cargo on one ship as it would to divide the cargo into 4 lots of £250 each.
- The expected loss is £250. Why do we think spliiting the loss into 4 loads as being less risky?
- The answer of course lies in the variance
- There are a number of ways of measuring variability or volatility.
- As an example we use the Mack method to calculate the mean and standard deviation of the chain ladder estimate for a set of claims data. By selecting an "appropriate" distribution we then estimate the 95th or 99.5th percentile, and take the difference between that and the mean as part of the capital required for the insurance risk

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CAPM

- One of the early methods of measuring risk was in the CAPM .
- Here volatility refered to the standard deviationof the change in value of a financial instrument with a specific time horizon.
- It was then used to quantify the risk of the instrument over that time period.
- Volatility is often viewed as a negative in that it represents uncertainty and risk. Volatility does not imply direction. (This is due to the fact that all changes are squared.). Thus the Mack method can be considered as a measurement of the volatility of the reserves in a similar manner to the CAPM measured the risk of a financial instrument
- It is a simple but not very good model

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CAPM

- CAPM has some shortcomings, and there have similar issues in the Mack and similar methods to insurance risk.
- Of these the most important are that the model assumes that the variance of returns is an adequate measurement of risk.
- This might be justified under the assumption of normally distributed returns, but for general return distributions other risk measures (eg the class of coherent risk measures) are more important.
- It also does not explain large variations seen in both stock market and reserve run offs

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Distinction between Risk and Uncertainty

- Frank Knight in his 1921 work “Risk, Uncertainty and Profit” established the distinction between risk and uncertainty.
- *“Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated. The term "risk," as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of economic organization, are categorically different. ... The essential fact is that "risk" means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating. ... It will appear that a measurable uncertainty, or "risk" proper, as we shall use the term, is so far different from an unmeasurable one that it is not in effect an uncertainty at all. We ... accordingly restrict the term "uncertainty" to cases of the non-quantitive type.”*

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A solution

- A solution to this ambiguity is proposed in "How to Measure Anything:Finding the Value of Intangibles in Business" by Doug Hubbard
- ***Uncertainty***: *The lack of complete certainty, that is, the existence of more than one possibility. The "true" outcome/state/result/value is not known.*
- ***Measurement of Uncertainty***: *A set of probabilities assigned to a set of possibilities. Example: "There is a 60% chance this market will double in five years"*
- ***Risk***: *A state of uncertainty where some of the possibilities involve a loss, catastrophe, or other undesirable outcome*
- ***Measurement of Risk***: *A set of possibilities each with quantified probabilities and quantified losses. Example: "There is a 40% chance the proposed oil well will be dry with a loss of $12 million in exploratory drilling costs".*

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A Solution

- Thus we have uncertainty without risk but not risk without uncertainty.
- There can be uncertainty about the winner of a contest, but unless there is some personal stake in it, we have no risk.
- By betting money on the outcome of the contest, risk is introduced. In both cases there are more than one outcome.
- The measure of uncertainty refers only to the probabilities assigned to outcomes, while the measure of risk requires both probabilities for outcomes and losses quantified for outcomes.

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Some further issues

- In the paper on Extreme Events, I mentioned the herd instinct as a key to understanding some of the historic losses. This herd instinct included the following
- Underwiter A made a fortune on his XL book last year The reason why Underwriter A made a fortune was there was no losses. However Underwriter B (a motor underwriter)is put under pressure to increase his profits just like Underwriter A. No measure of the risk takes place
- The same could be said about trading in the Dot Com market. If you controlled the risk by financial instruments then this would have significantly reduced the return in 1996,1997, 1998 and 1999.
- Since the trader is rewarded on the return (with no real downward risk) prudency is thrown out of the window
- In any case it wasn't his money!

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Some further issues with Modern Financial theory

- Why should this happen
- In standard modern financial theory, investment managers should not diversify, as the investors can do this more efficiently themselves.
- The trader should not consider the riskiness of a trade (and he certainly doesn't)
- The corollary of this is that risk management is of little value. Diversifiaction is ignored. Risk management costs are wasted as the invester could do it himself for free.
- However, in the real world the investor really wants stable earnings without volatility, in complete contradiction to the above.
- He wants good risk management

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What is wrong with existing methods

- Mack
  - We need to make assumptions regarding the distribution
- Bootstrap
  - We don't have enough data points
  - Even a 10 by 10 only 53 residuals
  - How can you do express a 1 in 100 event

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The issue over distributions

- A significant part of our analysis of uncertainty centres on the mean and standard deviation (or coefficient of variation) and then assumes a distribution such as Normal, Gamma or LogNormal to measure the percentile and hence the capital load for risk.
- No thought is given to the skewness or kurtosis
- Consider the surface of all possible skewness and kurtosis.
  - All normal distributions are at the point (0,3).
  - The excess kurtosis is the kurtosis minus 3
  - For a Gamma we have skewness and kurtosis closely related so that the possible ratios form a curve.
  - Similar considerations apply to the lognormal, when by fixing the skewness, we fix the standard deviation and thus the kurtosis Hence any data skewness or kurtosis outside of this point or line brings into question the validity of the distribution assumption.
- If we need to consider the skewness and the kurtosis as an entity . One way of solving this problem is by the use of copulas, which are weighted combinations of different distributions.

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Tukey g and h

- The alternate solution is to use a distribution devised by Tukey
- This is know as the g and h distribution and can incorporate the entire skewness/kurtosis plane.
- Tukey introduced a family of distributions by transforming the standard normal variable *Z* to

,

$$Y_{g,h}(Z) = \left(e^{gZ} - 1\right)\frac{\exp\left(hZ^2/2\right)}{g}$$

- where *g* and *h* are any real numbers. By introducing location (*A*) and scale (*B*) parameters, the g-and-h distribution has four parameters in the following form:
-

$$X_{g,h}(Z) = A + B\left(e^{gZ} - 1\right)\frac{\exp\left(hZ^2/2\right)}{g} = A + BY_{g,h}$$

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Tukey g and h

- When *h*=0, the g-and-h distribution reduces to ,

$$X_{g,0}(Z) = A + B\frac{(e^{gZ}-1)}{g}$$

- which is also known as the g-distribution. The *g* parameter is responsible for the skewness of the g-and-h distribution. The g-distribution exhibits skewness but no kurtosis.
- Similarly when *g*=0, the g-and-h distribution reduces to

$$X_{0,h}(Z) = A + BZ\exp(hZ^2/2) = A + BY_{0,h},$$

- which is also known as the h-distribution. The *h* parameter in g-and-h distribution is responsible for its kurtosis. The h-distribution has fat tails (kurtosis) but no skewness
- By this trick we blend the distributions

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Tukey

- Thus by using this distribution we can fit any skewness and kurtosis
- The problem is one of solving and simulating the distribution
- Nobel prize?

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Conclusion

- We have models which are at best crude approximations to reality
- We were sucked into a 99.5% regime with inadequate data – bootstrap is no solution if you have a small number of points
- We should not believe that results are at the 1 in 200 year level
- We should take care in explaining this
- What's a 9 between friends

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