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The Actuarial Profession
Risk and investment conference 2010

Hot topics – recent issues

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Agenda

Objective is to explore several (linked) themes & their implications for risk management:

- Some observations on the financial crisis:
  - Market prices and asset premia
- Some resulting 'hot' topics:
  - The price of liquidity
  - Dependence between asset returns in times of stress
- Some not-so-hot topics:
  - Governance, complexity, model risk and communication
  - Behavioural bias & its implications.

Market prices & Asset premia

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Some observations on the factors driving asset price changes

Some factors generally assumed to drive price & value changes:

1. Changes to underlying asset cash flow expectations
   - Changing expectations for future dividends and rental income
   - Changing expected default experience
2. Changes in risk-free discount rates
3. Variation in the level of risk
   - Volatility changes, Convexity effects
4. Variation in the price of risk
   - Time variation in risk premia ('fear & greed', 'animal spirits', 'disaster myopia')
5. Changes in the level & price of liquidity
6. Other asset premia
   - Volatility risk, currency risk

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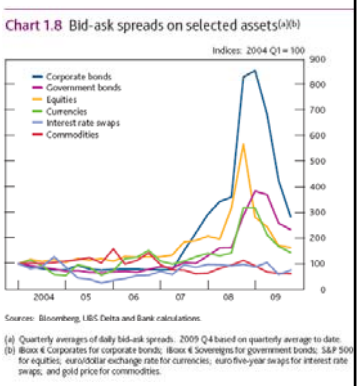
What happened in 2008?

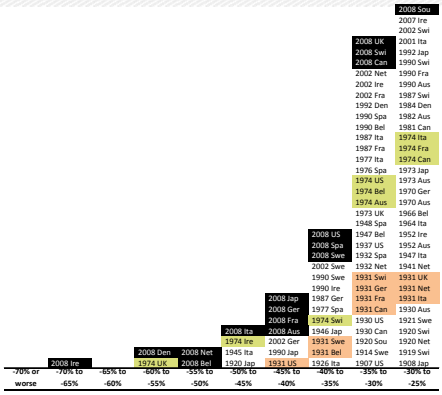
1. A deflationary shock to the global economy
   - Reduced growth and income expectations
2. Increasing uncertainty
   - Authorities' policy response (short rates)
   - Elevated volatility of asset prices
   - Increasing dealing costs
3. A collapse in confidence
   - Flight to quality / increasing risk aversion and risk premia (price of risk)
   - Flight to liquidity / increasing price of liquidity
   - Increasing volatility premia (i.e. option hedging costs & risk aversion)



*Source: *Bank of England Financial Stability Report December 2009*

Some observations

+ The 2008 market movements were perceived to be 'extreme' i.e. "*…that was the 1-in-200 year event*".
  - How might the world have changed to make this sort of event more likely / frequent?



+ The severity of *joint* behaviour is perceived as extreme.
  - The 2008 stress test would have been viewed as unrealistic by many decision makers beforehand.
+ Yet:
  - Many parallels with 1930s
  - This susceptibility to behavioural bias mirrors previous market dislocations.

Cognition & Decision Making

"Everyone complains of his memory, none of his judgment."
Duc de la Rochefoucauld, 17th Century

- Decision theory
  - Normative – how decisions should be made
  - Behavioural – how decisions actually are made
- Cognitive Errors: Tversky & Kahneman (1972)

Availability:	Events that are vividly remembered are weighted more heavily in the decision-making process.
Representativeness:	Tendency to focus on the unique qualities of the case data and fail to give sufficient weight to base data.
Anchoring:	When estimating the size of some variable, people are influenced by the initial "anchor" value

- People underestimate the errors around their forecasts.

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Some observations on models & modellers

In recent decades, a vast risk management and pricing system has evolved, combining the best insights of mathematicians and finance experts supported by major advances in computer and communications technology. A Nobel Prize was awarded for the discovery of the pricing model that underpins much of the advance in derivatives markets. This modern risk management paradigm held sway for decades. The whole intellectual edifice, however, collapsed in the summer of last year because the data inputted into the risk management models generally covered only the past two decades, a period of euphoria. Had instead the models been fitted more appropriately to historic periods of stress, capital requirements would have been much higher and the financial world would be in far better shape today, in my judgment.

..the predominant assumption was that increased complexity had been matched by the evolution of mathematically sophisticated and effective techniques for measuring and managing the resulting risks. Central to many of the techniques was the concept of Value-at-Risk (VAR), enabling inferences about forward-looking risk to be drawn from the observation of past patterns of price movement... The very complexity of the mathematics used to measure and manage risk, moreover, made it increasingly difficult for top management and boards to assess and exercise judgement over the risks being taken. Mathematical sophistication ended up not containing risk, but providing false assurance that other prima facie indicators of increasing risk ... could be safely ignored.

Testimony of Dr. Alan Greenspan to the Committee of Government Oversight and Reform on October 23, 2008
http://oversight.house.gov/documents/20081023100438.pdf
FSA / *The Turner Review: A regulatory response to the global banking crisis*, March 2009, page 22

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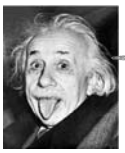
Greenspan / Turner

Let's blame the modellers

- Calibration to an inappropriate past period.
- 'Misplaced reliance on sophisticated maths'
  - Models were too complex for top management to understand.
  - Models were too simple to capture complex risk exposures.
- Mathematical sophistication created false assurance.



Everything should be made as simple as possible, but not simpler.

- Probably the biggest challenge for modellers is their interaction with firm management, regulators and accountants.
  - Complexity or simplicity?
  - Gaming and behavioural bias.

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Hot topics

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What is the liquidity premium?

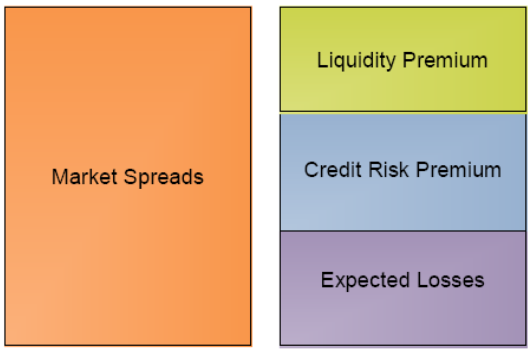
The basic idea

- The basic idea is that financial instruments which offer identical cash flows can sell at different prices as a result of their trading liquidity.
- Hard-to-trade instruments will sell at a price discount (or yield premium) compared to otherwise equivalent assets as a result of demand from 'mark-to-market' investors.
- Liquidity premia have implications for the fair valuation of illiquid liability cash flows.
  - If markets price liquidity then market-consistent valuation techniques would be expected to value illiquid (i.e. predictable) liability cash flows in a consistent way.
  - The illiquid replicating asset portfolio reveals the 'correct' liability value.
- LP pro-cyclical in behaviour?

A reminder: Decomposition of market spreads

The corporate bond spread can be decomposed as:

- the expected default loss on bonds;
- plus the risk premium that investors demand for the possibility that corporate defaults will be higher than expected;
- plus a liquidity premium to compensate for the expected costs (and uncertainty of those costs) of trading bonds.



Researchers' conclusions

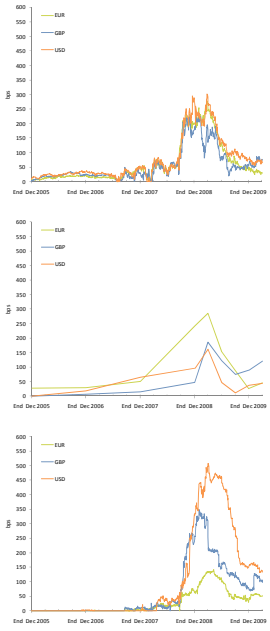
- There is a vast literature on liquidity premia in many asset markets (including bonds).
- Estimates for long-term LP vary considerably from 3-5% pa in small cap equities to c 0.1% in government bond markets.
- Estimates of corporate bond LP magnitudes vary – liquidity premium typically 10-50 bps but higher during stress periods.
- Mixed evidence, but the clear consensus is that:
  - Liquidity premia do exist in corporate bond markets
  - They can be substantial
  - They vary significantly through time.

Estimation methods

Consider the following approaches to estimation:

1. A comparison of yields on risk-free liquid bonds with an equivalent position in corporate bonds protected against default risk using CDS (the 'negative CDS basis').
2. A Structural ('Merton') model used to infer a fair spread on a liquid asset using option pricing theory which can be compared with market yields on equivalent illiquid bonds.
3. Direct computation through pairing with otherwise identical liquid (or relatively liquid) assets as proxies to LP in corporate bond markets.

There is no single correct method to estimate the liquidity premium. Each of the three identified methods in isolation has advantages and disadvantages; however, combined the methods provide clear evidence of the liquidity premium.



Dependence in returns

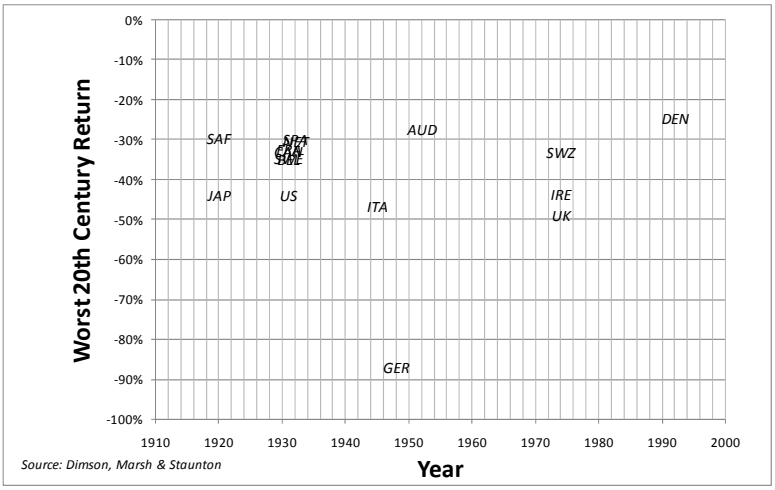
Average 10-day correlation across major equity markets

- The correlation coefficient is the statistician's standard tool for describing dependence.
- Average 10-day correlation across US, UK, Japan, Germany & France was 87% over 2008 (to end October 2008).
- Average 'unconditional' equity correlation remains c*0.50*

	Japan	France	UK	Germany
Japan				
France	85%			
UK	83%	95%		
Germany	86%	95%	91%	
US	80%	84%	85%	84%

Average = 87.0%

Worst 20th-Century Returns



Some not-so-hot topics:
What should we be talking about?

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Governance, complexity, model risk & communication

- Policymakers face a challenge in ensuring senior management are accountable for models whilst recognising the inherent conflict between complexity and understanding.
- A primary function of financial intermediaries is to understand and manage complex exposures.
- There are natural constraints on the technical dialogue between firms and their modellers.

Questions:

- *Does this impact the nature of the interaction between modellers and senior management?*
- *Does the need of the senior management to understand influence the way we build models?*

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A spectrum of choices the model builder

- Fully modular / pure statistical / descriptive
  - General specification of marginal distributions and dependency.
  - Single period.
  - "*The general problem of the modular approach remains that the specification of dependence is exogenous to the individual risk models. It involves an ex post, phenomenological description of the effects of dependence rather than an explicit structural attempt to explain the causes of dependence.*" *
- Highly structural models
  - Attempt to match real-world complexity with model complexity.
  - Doomed to failure.
- B+H ESG models fall towards the statistical end of this spectrum
  - Impose structure where we have strong beliefs and in order to respect arbitrage boundaries and market economics.
  - Does the model inform and extrapolate or simply fit observed data?

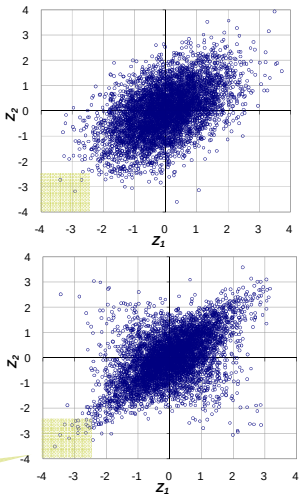
** The Case for Fully Integrated Models of Enterprise Risk and Economic Capital Management: Draft paper McNeil, Kretzschmar, Kirchner*

So, what strong beliefs can be embedded into model structure?

- Equity-type asset returns are driven by common factors which themselves are subject to bouts of extreme instability.
- Returns to credit-risky assets arise from a Merton-style linkage between firm equity values and creditworthiness i.e. asset price falls should be associated with negative credit shocks.
- Yield curves should be built using arbitrage-free models.
  - Avoid accidental unanticipated excess returns to some strategy or portfolio.
- All asset returns should be built – in some way – around a risk-free rate.
- Inflation paths should be consistent with yield curve behaviour (real and nominal).
- Currency behaviour should be capable of respecting purchasing power parity theory.
- Etc…

Copulas

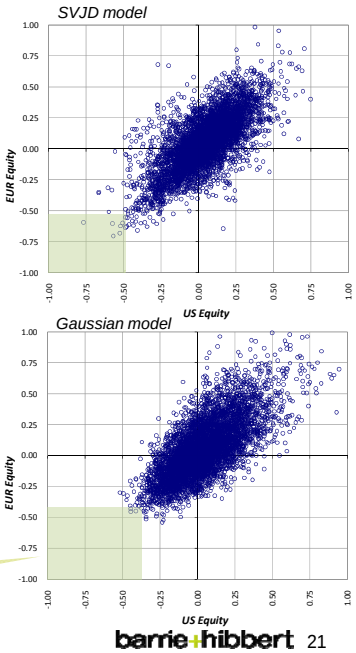
- Copula methods offer the prospect of:
  - capturing the entire dependency structure
  - an ability to separate the description of dependency from the '*marginal*' distributions.
- Compare *5000* sample random variates drawn from the same marginal distribution (Gaussian) and sharing the same linear correlation (*0.50*) but which exhibit different dependency in the tails:
  - "*Gaussian Copula*" = Dependency structure of the multivariate normal distribution (top chart)
  - "*t-Copula*" = Dependency structure of the multivariate t distribution (bottom chart).



If returns are correlated 0.50, the probability of observing a joint event beyond the 99th %tile (given one observation) is approximately 10% for the Gaussian Copula & 40% for the T Copula.

SVJD compared to Gaussian model

- The SVJD model incorporates a time-varying systematic volatility component into all equity-type assets.
- This changes the shape of univariate distributions and creates stochastic correlation (and strong tail dependence).
- The charts compare 2 models for returns for EUR and US equities which have common mean, standard deviation and correlation.
- Note the difference in higher moments, tail location and tail dependence.



Returns are correlated 0.70 and the probability of observing a joint event beyond the 99.5th %tile (given one observation) is approximately 23% for the Gaussian Copula & 40% for the SVJD model using B+H's end-Sep 2009 'real-world' calibration.

Conclusions

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Conclusions

- The 2008 financial crisis was a brutal reminder of the potential severity of asset price changes and the complex factors that drive financial markets (including liquidity effects).
- Both the severity of price movements and the joint behaviour of assets should be viewed within the context of very long-term experience and what we understand about market economics.
- Modellers and management face a challenge in managing the conflict between real-world complexity and the need to understand and explain.
- Management can create a meaningful dialogue in order to understand shortcomings of models:
  - By accumulating sufficient technical expertise;
  - And/or by developing a set of beliefs / stylized facts to test against the models;
- Management and modellers need to appreciate their own inherent behavioural bias and actively work to "*think outside the box*".

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