How Catastrophe and Financial Modelling Revolutionised the Insurance Industry

David Simmons: Managing Director, Capital, Science and Policy Practice

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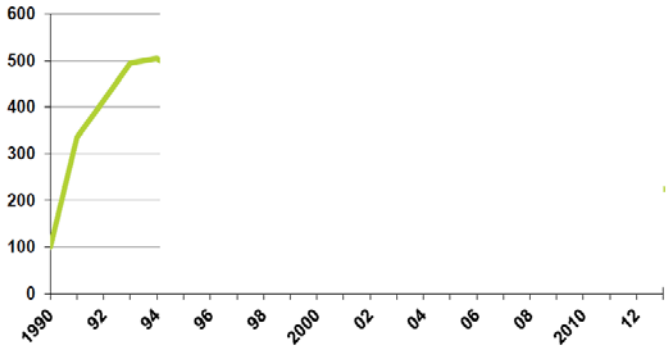
Catastrophe Reinsurance Pricing
The "Traditional" Model

- Catastrophes are, by their nature, rare events
  - Before the "modelled age" pricing was based upon recent loss history and required return
  - Pricing at near return period dictated by recent history (burning cost)
  - Pricing at far return periods set by minimum return requirements (minimum rate on line)
- Concept of "the bank" and "payback" prevailed
  - When loss occurred reinsured was in effect calling in their "bank" of premiums paid in clean years
  - If bank insufficient then rates in future years increased so that reinsurer was paid back over a fixed time period
  - But these arrangements were non-contractual, market practice only
- Result was that catastrophe reinsurance pricing was very reactive
  - When losses occurred prices increased steeply
  - In period of no losses prices tended to drift down due to market pressure
  - Exacerbated by tendency for some reinsurers to exit post-loss and new entrants emerge when rates are high

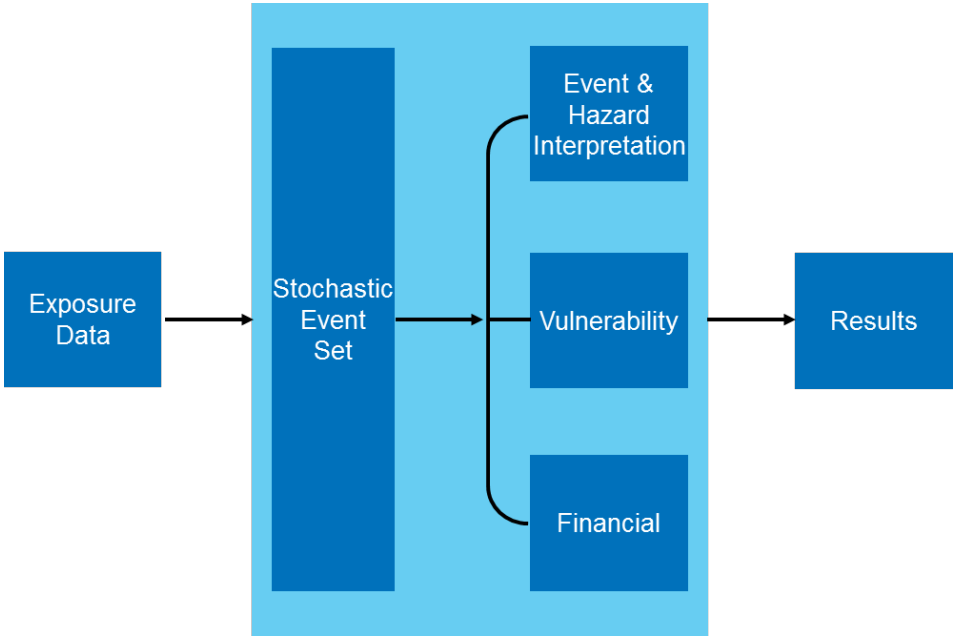
Catastrophe Reinsurance Pricing
1990s UK Catastrophe Example

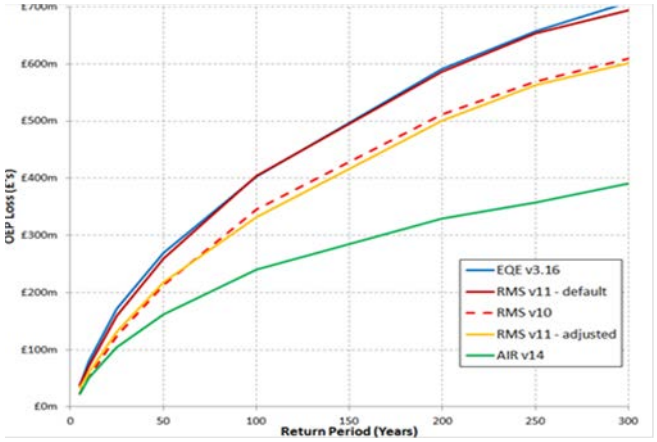
- Catastrophe Market in 1990 was already stressed
  - Large “1 in 100” windstorm loss in 1987 - 87J – USD 3.1m (original values per Munich Re)
  - Other market losses: Piper Alpha and Hurricane Gilbert (1988), Hurricane Hugo Exxon Valdez tanker (1989) tested catastrophe and specifically the Lloyd’s market
- Storm 90A or Daria in January caused insurance losses event greater than 87J – USD 5.1m
  - Followed by a series of other smaller storms including Vivian in February costing USD 2.1m
- In 1991 UK catastrophe prices reinsurance prices spiked in reaction to these losses
  - Prices more than tripling on average (source Willis Re)
  - Prices continued to increase in 1992 (impact of Hurricane Andrew) and 1993 as the LMX spiral, partially caused/revealed by this sequence of losses reduced ability of reinsurers to protect themselves so further reducing capacity
  - Prices peaked in 1994 with UK catastrophe reinsurance rates over 5 times 1990 levels



The Answer : Catastrophe Modelling

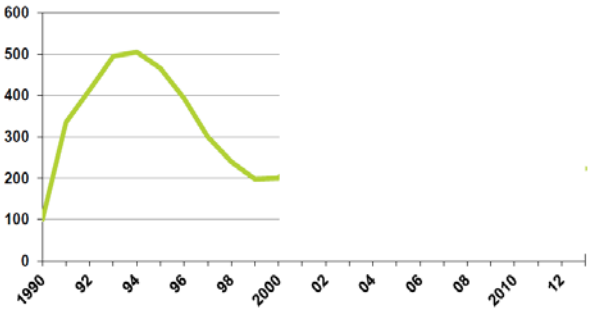
- In 1984 Don Friedman published a paper outlining how to model catastrophe losses using simulated events
- Put into practice by Karen Clark, working fro reinsurance broker Blanche, in the late 80s for US Hurricane (cleverly she kept the IPR)
- In early 1991/2 London reinsurance broker Greig Fester created the first UK storm and flood models





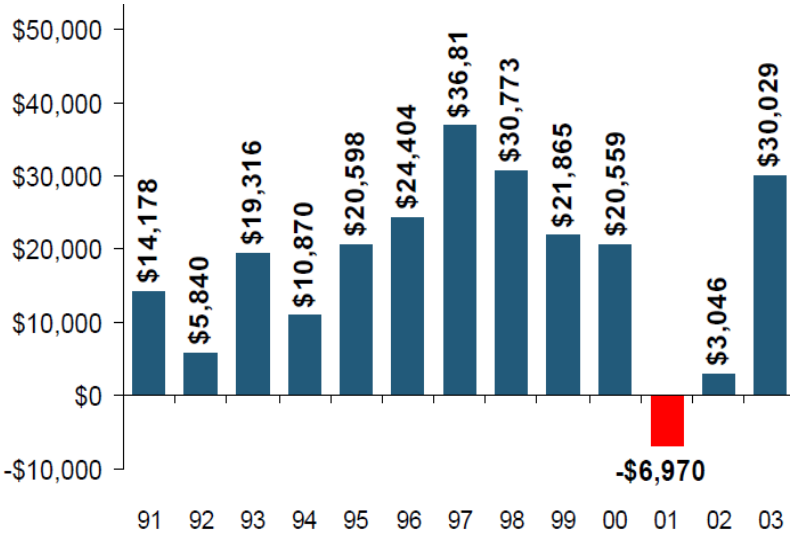
The Brave New Modelled World

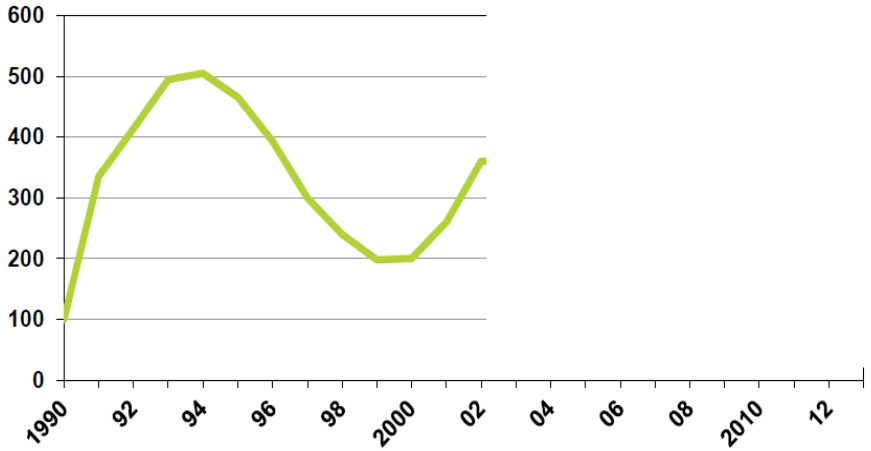
- Prevailing view was that new modelling would damp reinsurance pricing movements
  - Pricing now technical rather than reactive
  - New market entrants in Bermuda aggressively predicated their offering on this new technical approach
  - Beginning of breakdown of old bank/payback model
  - Insureds were tempted by lower prices of new technical reinsurers, breaking gentlemen's payback agreements
- Threat of Capital Markets entry to market was widely believed to further constrain pricing
  - New Bermuda capital could leave as fast as it arrived, triggering price increases?
  - But capital market players, with "infinite capital" attracted to new zero beta class would stay/pile in post loss?
  - Prices declines steadily from 1994 to 2000 as confidence In the modelling increased and memory of 1990 weakened, helped by a benign period for European Storms and the broader global catastrophe market



But shocks still have an impact

- 9/11 in 2001 provided an unexpected shock to the system
  - Not a UK loss, not a natural catastrophe, but a major threat to the health of reinsurers
  - Market Loss circa USD 32m, over 50% higher than the highest natural catastrophe, Hurricane Andrew
  - P&C insurers suffered real losses to their capital (chart below source Insurance Information Institute)
  - Price impacts were felt throughout the market, UK prices jumped despite there being no underlying change to the assessed UK catastrophe risk and no actual UK catastrophe losses
  - The reactive kick-up in pricing was not limited to the UK – all markets showed a similar picture
  - Although not a model failure, the multi-class nature of loss caused reinsurers to question their base assumptions



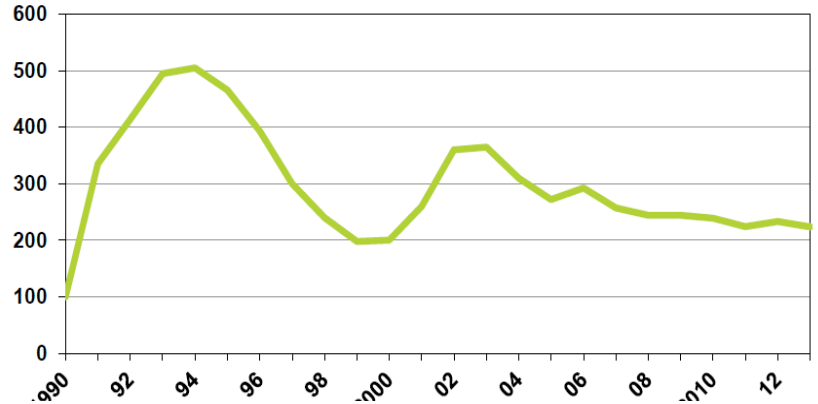


Post 9/11
A series of disappointments

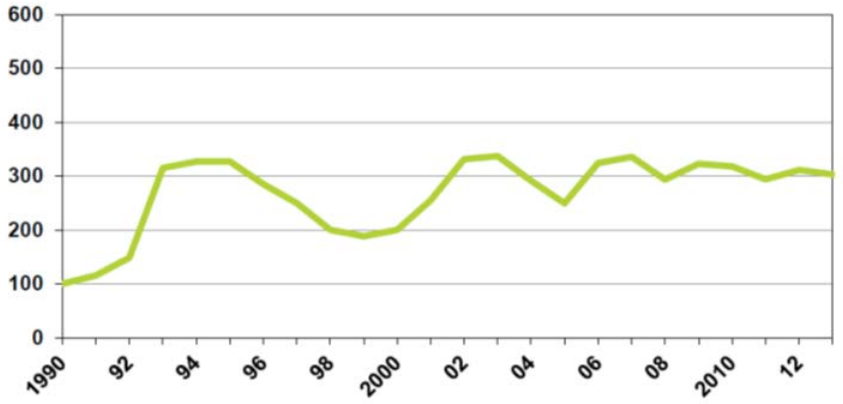
- The catastrophe market has proven to be very resilient in the current millennium despite a series of major events, each revealing a flaw in underlying modelling assumptions
  - Hurricane Katrina: Levee burst/flood not modelled
  - Hurricanes Katrina/Rita/Wilma: Hurricane clustering
  - Sichuan Earthquake: Missed fault
  - Japanese Earthquake: Tsunami not modelled, intensity of earthquake on fault
  - New Zealand Earthquake: Liquefaction impacts, intensity of earthquake on fault, aftershocks
  - Australian Flood: Unmodelled, scale/intensity, classification (riverine vs flash flood)
  - Thai Flood: Unmodelled, contingent business interruption claims, scale
- But the re/insurance industry remained resilient to all of these despite modelling flaws
  - Why? Despite problems with catastrophe models, their introduction has lead to as greater appreciation of risk, portfolio development, aggregate control and data quality
- Capital market involvement in reinsurance is growing BUT not reason for stability
  - Capital markets took fright after “model error” of Katrina, retreated from indemnity deals to parametric trigger
  - Now back, largely driven by seeking any asset with a return with low correlation to market risk
  - Ironically, it was market risk that caused the biggest impact on re/insurers, the 2008/2009 asset crash, but no significant long-term casualties (other than AIG)

Pricing trends from 4 major markets

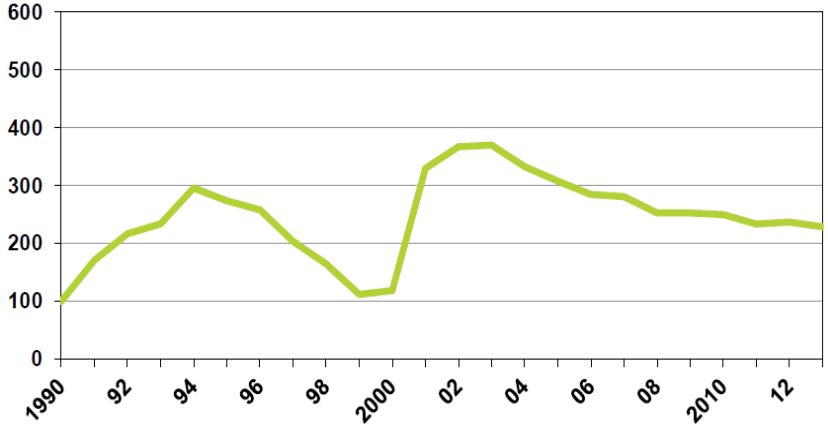
U.K.



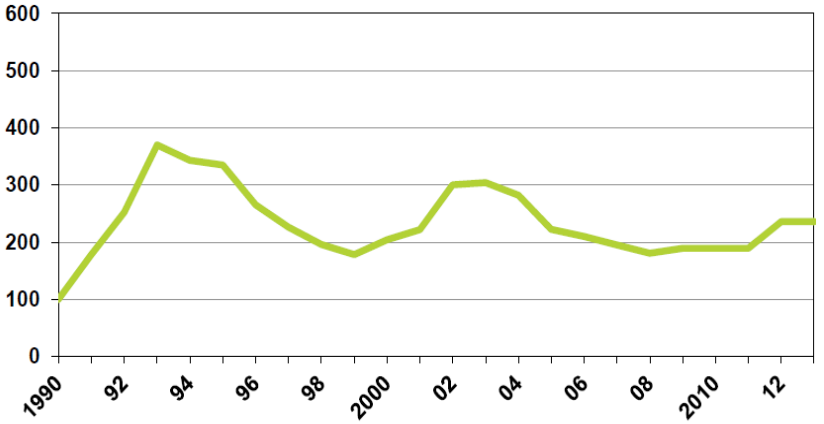
U.S. – Nationwide



France



Australia



The Psychology of Catastrophe Model Use

- The human dimension catastrophe model use cannot be overlooked
  - In 1990s the London market particularly was losing business to more technical “professional reinsurers”
  - Reinsurance brokers’, then modelling firm’s, catastrophe models were the solution
  - At least we had a new rational way to access the value of, and price, reinsurance

But…

- The early catastrophe models were oversold and over bought
  - Modellers downplayed the inherent uncertainty in the models
  - Model “buyers” didn’t want to hear about uncertainty
- Early commercial (vendor) models were black boxes
  - Modellers protected their IPR jealously
- It was the age of “the computer says no” (or more dangerously yes)
  - Insurance companies had little in-house expertise in catastrophe modelling
  - Many reinsurers bought into the idea without necessarily investing in understanding
  - There were beacons but most of the re/insurance market was pretty naïve
  - The capital markets even more so – no differentiation between models
- In retrospect were we lucky that the late 1990s were mostly benign but things were changing
  - Greater engagement with science
  - Growing technical teams in reinsurance brokers to “deconstruct” and challenge vendor models
  - Growing in-house expertise in reinsurers and larger insurers

Scientific Engagement

- In the 1990s the industry began to engage with academia
  - Greig Fester Hazard Research Centre at University College London
  - Risk Prediction Initiative driven by the Bermudan Biological Research Station
  - TSUNAMI: UK market scientific consortium lead out of the British Antarctic Survey
- But initial engagements had limited success
  - Language/communication difficulties
  - Tough to implement findings within existing models
  - Lack of time/personal to take results forward
- But the situation is improving
  - Financial modelling tools (eg Igloo) allowed imported catastrophe modelling results to be amended and stressed
  - Better research engagement models emerged, eg Willis Research Network
  - More “scientific staff” within reinsurance brokers and re/insurers to review and incorporate scientific findings
  - Many insurers now have Chief Scientific Officers

Willis Research Network Members

Regulatory drivers

- Regulation also encouraged the change towards a more considered approach
  - Banking-led principles based regulation placed onus on firms to understand their own risks
  - UK led the way with creation of FSA in 1997
  - The Basel process inspired ICAS regulatory framework required UK insurers to access their capital requirement
  - Most larger firms interpreted this as meaning they should build a stochastic capital model
  - A large driver of most firms capital was catastrophe risk
- Solvency II has cemented this change
  - There is much that can be said against Solvency II (the EU's "new", much delayed regulatory regime
  - Solvency II is bloated, over bureaucratic, expensive and a general pain in the ….
  - But at the heart is the excellent concept of "own view of risk"
  - Firms cannot shelter behind the opinions of others, they must own their own risk assumptions
  - This has given further impetus to closer scientific engagement and a more academic approach
  - Vendor catastrophe modellers had to be far more open about the assumptions within their models
  - Suddenly the language changed, now longer "trust us we are the experts" to "it is you call what assumptions to use but we can help you"
- Similar regulation is emerging across the world
  - Encouraged by the International Association of Insurance Supervisors' "Insurance Core Principles (ICPs)
  - ICPs also require firms to test their own risk assumptions
  - Even the US, which won't even contemplate the principle of equivalence with Solvency II, has adopted the ORSA (Own Risk Solvency Assessment)

So where are we now

- We have a much more resilient catastrophe re/insurance industry
  - Much more scientific
  - Much more technical,
  - Much smart
- Capital markets aren't mugs either
  - Growth in catastrophe funds matching reinsurers in technical knowledge
  - Also provide glue to ensure capital sticks if a major loss occurs
- All in the garden is not perfect
  - Not all the world is modelled
  - Not all perils are modelled
  - Not all risks are modelled (residential property bias)
  - Many perils are intrinsically difficult to model (especially flood)
  - The uncertainty is models arguably is still inadequately understood
- But there are many reasons for optimism
  - Models improve as understanding improves
  - Use becomes more intelligent "models advise, they do not decide"
  - Governments and other industries are beginning to embrace the approach
    - "1 in 100 initiative": endorsed by FSB
    - Enhanced recognition that insurers are onto something
  - Methods being applied to other perils
    - eg drought, terrorism, cyber, pandemics

Some caveats

- Is there potential systemic risk from model use?
  - Regulators (eg Solvency II) are avoiding endorsing a model or models (like Florida) rather encouraging companies to take their own view of risk
  - BUT in practice difficult to be the one different from the others
  - “Don’t get sacked for buying IBM” = “Don’t get sacked for using RMS?”
  - Need contrarians to ensure robustness?
- Be wary of surprises
  - Many Japanese insurers suffered more form the Thai Floods than the Japanese Earthquake/Tsunami
  - It’s the unknown unknowns that hurt every time
- New potential users of catastrophe models risk making the same mistakes as the re/insurance companies made in the early days
  - Naïve use, wanting to believe
  - But there are reasons to hope that lessons have been learnt

Positive initiatives

- Greater modelling transparency
  - Greater vendor model openness, partially under regulator pressure
  - Open platforms being developed by RMS and AIR
  - A new open-access model OASIS is now ready to go
  - Makes it easier for academics to contribute towards model development
  - Aim to create an open market in exposure, hazard and vulnerability elements of models to common data standards
- Greater inclusiveness
  - G8 pledge to bring 400m vulnerable people under shelter of climate insurance
    - Coupled with funding promises after Paris climate conference
    - Potential kick-start to extend modelling to the developing world modelling initiatives
  - Creation of the Insurance Development Forum (IDF)
    - Co-chaired by Jorge Levy (World Bank CFO), Helen Clark (United Nations), Stephen Catlin (Insurance)
    - Charged with removing barriers to creation of catastrophe insurance schemes
  - IDF includes Resilience Modelling and Mapping Forum
    - Sub-group chaired by CRO of Renaissance Re, one of the smartest catastrophe reinsurers
    - Already operational
    - Charged with encouraging creation and access to models beyond current model scope (eg governmental risk, new countries and perils)

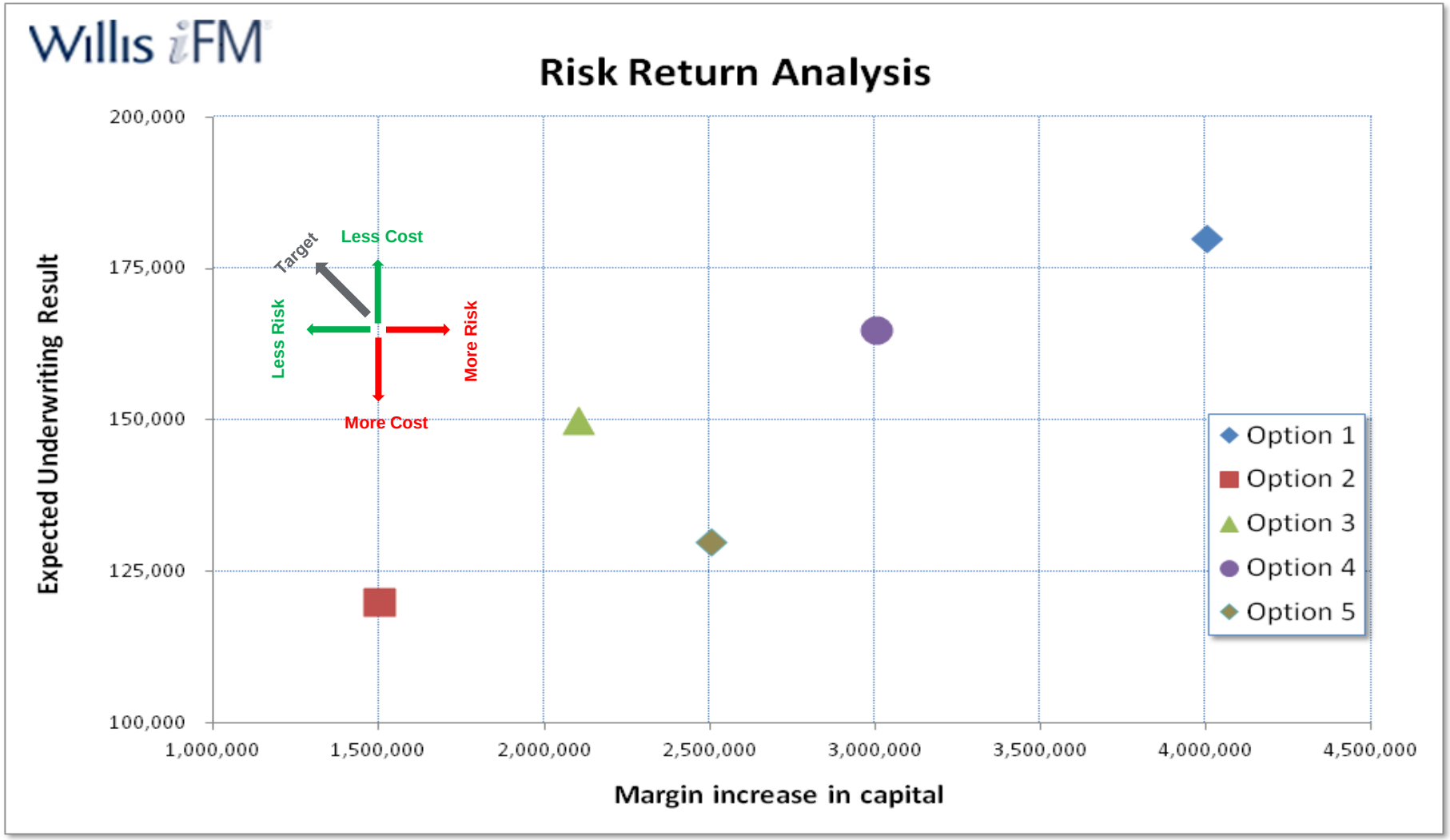
A brief couple of thoughts on Capital Modelling

- There are no barriers to building detailed capital models
  - Modelling software, eg Igloo, is mature
  - Modelling best practice well established
  - Hardware is cheap
- Explicit risk appetite statements allow targeted decision making using an internal model
  - Trade of between mean return, result volatility control and regulatory capital margin maintenance
  - Issue then becomes one of decision-making frameworks

BUT

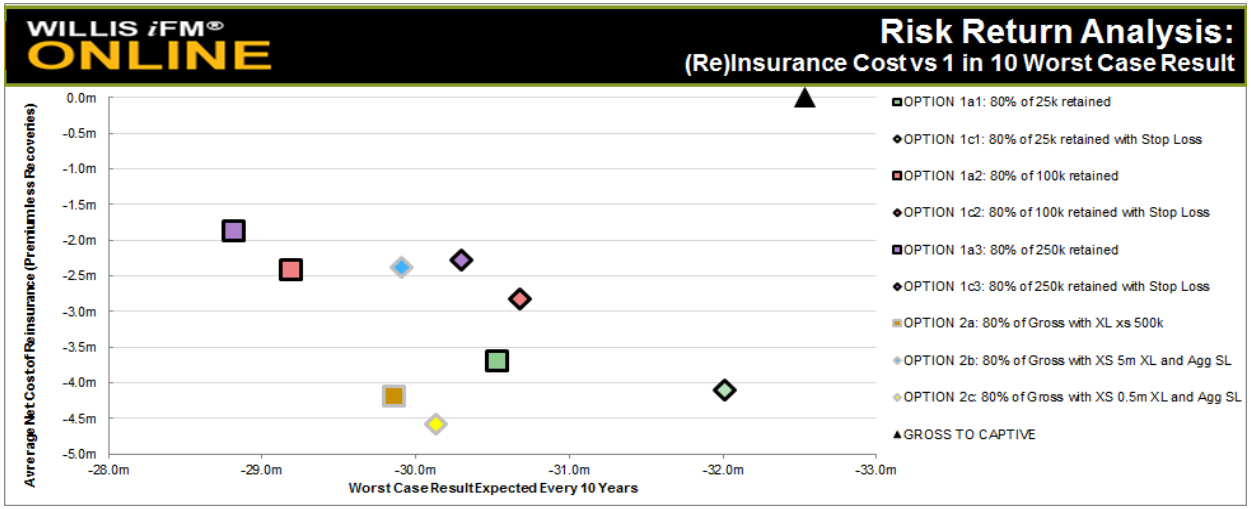
- There are concerns
  - “Too few actuaries in the world”
  - Group think penalises innovation
  - Regulation which should be encouraging challenge process seems more interested in box-ticking
  - Too many regulators see and internal models as an attempt to arbitrage regulatory capital
- The answer must be the Use Test
  - But few concerns have properly integrated their models into board and management level decision-making
  - Development of the business plan and internal model should be hand in hand
- But is there still a still geek vs real business distinction?
  - Need business-savvy actuaries and numeric underwriters/managers
  - Don’t expect everybody to be able to do everything but distinction between the too camps must be blurred
  - The Us test, not us and them

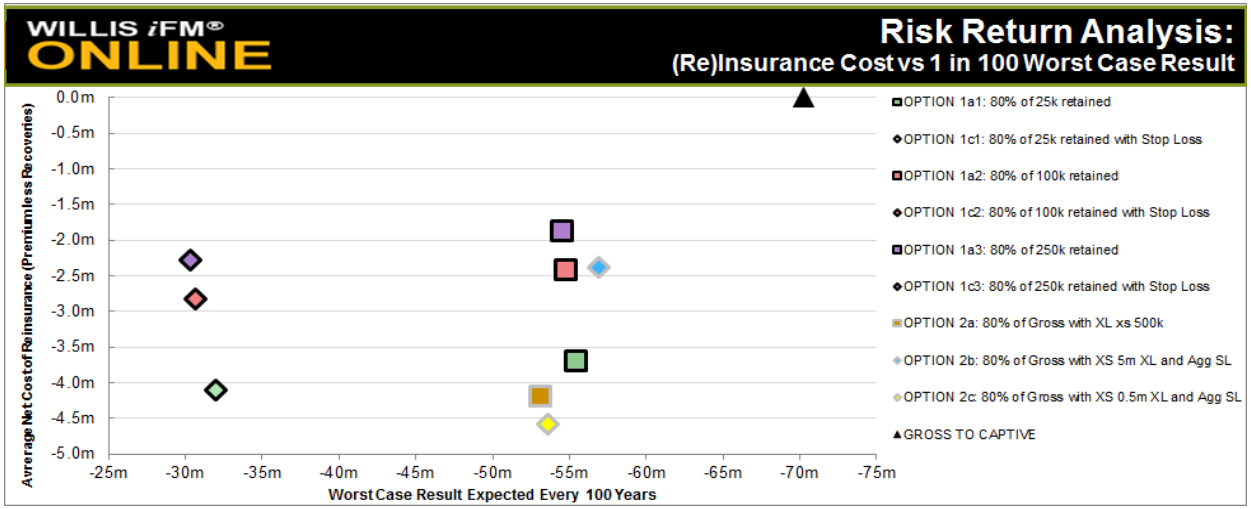
Risk vs Return



Developing A Decision Making Framework

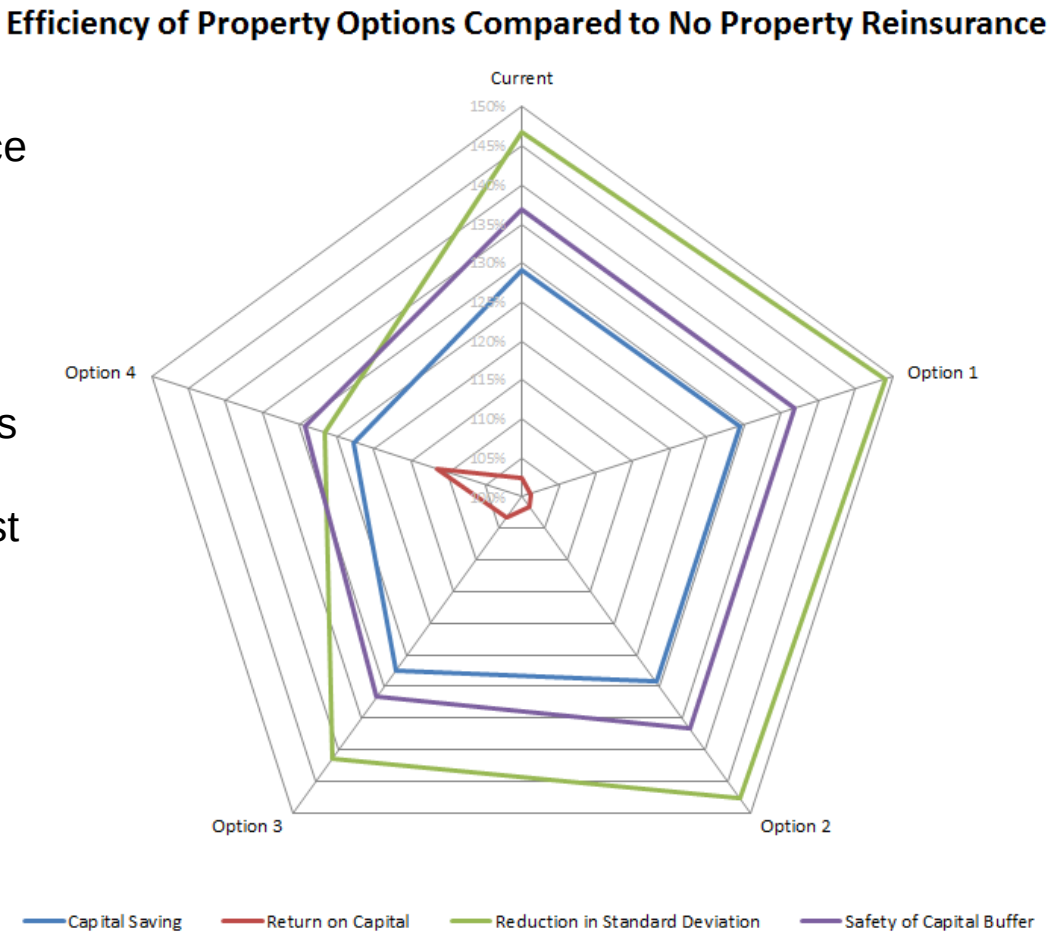
- What is optimal for an earnings measure will rarely be optimal for capital
- Increasingly decision making will need to be nuanced
- The challenge – to design products to meet multiple objectives
- Your reinsurance broker should help you agree a decision making framework





Example: Comparing Option Efficiency against all KPIs

- Reinsurance options are compared to the equivalent measure for the no reinsurance option
- The closer to the edge of the web, the more efficient the option
- Here the option at 10 o'clock is clearly optional for Return on Capital but sub-optimal against the other three measures
- But which risk measure(s) will drive the decision?



Conclusions

- Catastrophe and Financial Modelling has revolutionised the Insurance Industry
  - It has hard to overstate how the industry has changed
  - Moved from “underwriter born not made” to a technically aware, scientifically driven market
- But there have been mistakes on the way
  - It has taken the market time to realise how best to use the models
  - And we are still some way from properly embedding models within broad decision–making
- Regulation has driven the process forward
  - But often more by accident
  - Concept of “own risk” is positive, but risk of groupthink by regulators and companies; tough to be different
- A new dawn may be approaching
  - Open access catastrophe platforms and developing data standards
  - New industries embracing the modelling techniques pioneered by re/insurance
- A time of great opportunity
  - For modelling professionals: new challenges, new markets
  - For re/insurers: new markets, new products
  - For society: greater risk understanding, greater resilience

BUT

- Let’s not forget the limitations of knowledge and the extent of uncertainty
- Always remember: models advise they do not decide

Contact

David Simmons
Managing Director
Capital, Science and Policy Practice

david.c.simmons@willistowerswatson.com
+44 20 3124 8917