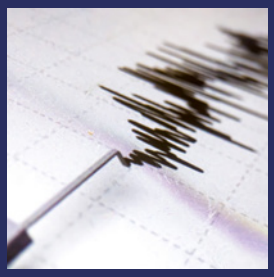
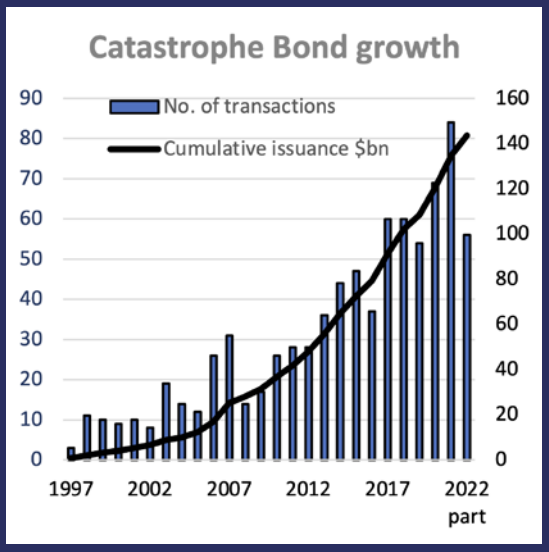
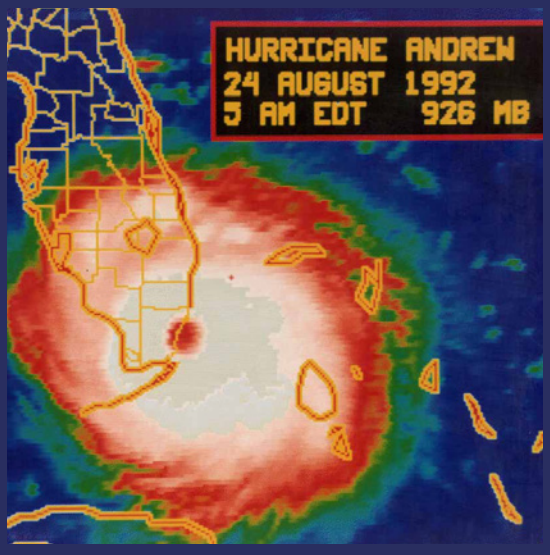
A Celebration of 25 years of Insurance-Linked Securitisation **through 25 Landmark Deals**

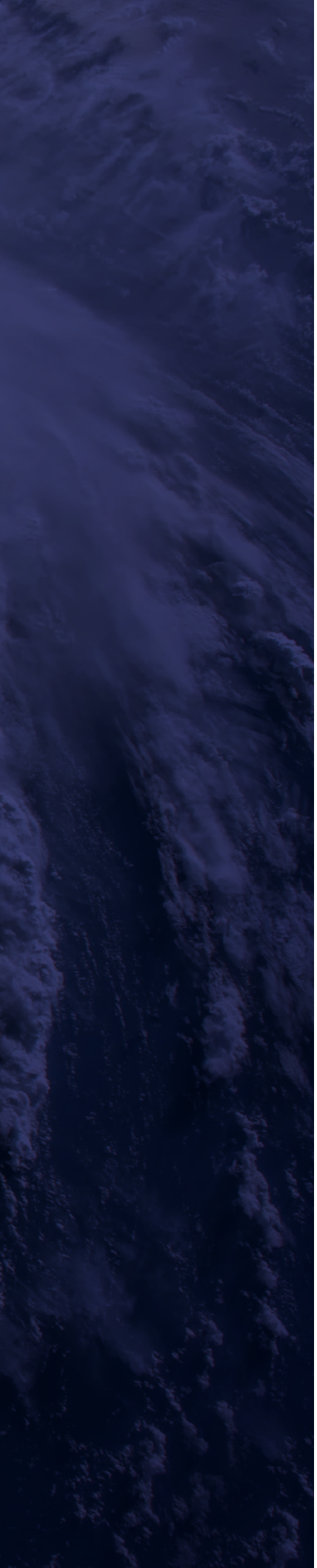
Dr Alan Punter








“It became abundantly clear that the (re)insurance industry could one day need access to a new, greater source of risk capital in order to survive”



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Dr Alan Punter

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Foreword by Sponsor

The earliest catastrophe securitizations appeared 25 years ago. They have grown into an insurance-linked securities ("ILS") market of over $100 billion including cat bonds, sidecars, collateralized reinsurance ("CRI"), derivatives and other structures. In turn, this growth has instigated and encouraged the growth of capital markets participation in adjacent insurance sectors ranging from runoff life and casualty, to emerging financial lines, and the burgeoning cyber risk market.

This market appeared and grew over the past quarter-century because it filled two pressing needs. First, issuers needed bulk risk capacity – particularly in retrocession and US Wind subsectors. Second, investors needed assets that diversified capital markets risk. A decade into this endeavor each side had a chance to stress test these structures. In 2005, Hurricane Katrina left a hole in reinsurance market capacity that the capital markets filled over the next several renewals. In 2008, the Financial Crisis highlighted the value of diversification as the ILS market performed well. The sector grew an order of magnitude over the following decade along with a cohort of specialized managers.

Alan Punter has done a brilliant job summarizing that history and the major benchmarks in the development of this market. He captures a number of transactions that broadened the market to include risks outside of the cat sector, a trend which may be the most important over the next 25 years.

We are well into a second stress test. Five consecutive years of elevated catastrophe experience have challenged market pricing and modeling. Some investors have decided to seek other lines of business, some have left the sector all together, and still others are still looking for the right re-entry opportunity. Risk measurement is being revised to take account of climate change, elevated event frequency, social inflation, and economic inflation. The needs that drove growth in the sector are more urgent than before. The reform and broadening of today's ILS market arising from this second stress test could set the stage for a tradeable, global insurance market another order of magnitude larger by the time its fiftieth jubilee arrives.

Michael Millette

Founder & Managing Partner, Hudson Structured Capital Management

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Introduction to 25 landmark deals

It was Friday 20 December 1996 in the New York offices of Goldman Sachs. The innovative George Town Re transaction was due to close that day, after having been worked on for nearly a year, and the deal team were looking forward to finally taking some time off and travelling to join their families and friends for the Christmas festivities. Then the news came through – there was a last-minute hitch and the team would have to reassemble after the weekend – awkward telephone calls were made, travel plans changed. Nevertheless, the remaining problems were sorted and the transaction, generally regarded as the first cat bond, finally closed at 4pm on Monday 23 December 1996.

The exact characterisation of the transaction is open to some debate. George Town Re provided coverage to its sponsor St Pauls Re UK on a quota share reinsurance basis, and so the transaction could be regarded as what has since become known as a 'sidecar'.

However, whatever the terminology, this transaction was the start of a remarkable quarter of a century of innovation and growth and transformation within the 700 years plus of the reinsurance industry[1].

The most common form of ILS is a structure known as a Catastrophe Bond (or 'cat bond'), under which a fixed income bond is placed into the capital markets, but repayment of some or all of the principal is 'at risk' from the occurrence of a pre-defined insurance event or events.

From this first $68.5m transaction, cat bonds are now estimated to have provided a cumulative total of over $144bn of risk capital up to the end of June 2022[2] – and the number of entities that have sponsored one or more cat bonds over these 25 years totals in excess of 200. The total amount of cat bonds and other ILS risk capital currently outstanding as at end 2021 was $37.75bn – the modal tenure of cat bonds is 3 years.

More generally, including such structures as cat bonds, sidecars, collateralised reinsurance and Industry Loss Warranties (ILWs), Insurance Linked Securitisation (ILS) now provides around 15% of the estimated $600bn of reinsurance capital worldwide (according to Aon Securities). However, it has not always been a smooth or steady growth path – there have been a few bumps along the way, particularly one major disruption caused by an unexpected consequence of the collapse of Lehman Bros in 2008 (details later).

The earliest transactions covered more or less exclusively natural perils (particularly US hurricanes and earthquakes, and Japanese earthquakes), but since then the list of perils covered by various cat bonds in force now additionally includes mortgage insurance risks, motor-third party liability, temperature risks, medical benefit claims level, operational risks and even lottery winnings. Alongside this expansion in the range of non-life perils that have been securitised, there have also been significant developments in securitising life perils such as abnormal or extreme mortality and longevity.

1 The first recorded reinsurance contract is believed to date from 1370 and covered a ship sailing from Genoa to Bruges.

2 All market figures are sourced from www.artemis.bm, unless otherwise stated.

For those of us that were around in the early years of ILS, the diversity of contract structures and perils now covered by ILS in one way or another is a source of wonder and pride – and some sort of answer to the naysayers from back then (not that they have all yet gone away!).

This book highlights the development of cat bonds and other related ILS structures over the 25 years up to June 2022 by reviewing the key features of 25 landmark deals over this period. These deals are a personal selection, chosen mostly because they were the first to introduce a new structure, to incorporate a particular contract feature, to cover a new peril, to introduce a new class of sponsor, or to have stood out for some other reason. Most of the ILS deals considered below are cat bonds, which are split into three sections – (A) cat bonds covering primarily property catastrophe risks; (B) cat bonds covering non-property, non-life risks; and (C) cat bonds covering life & health risks. Also considered are notable examples of two other ILS structures – (D) reinsurance sidecars; and (E) contingent capital.

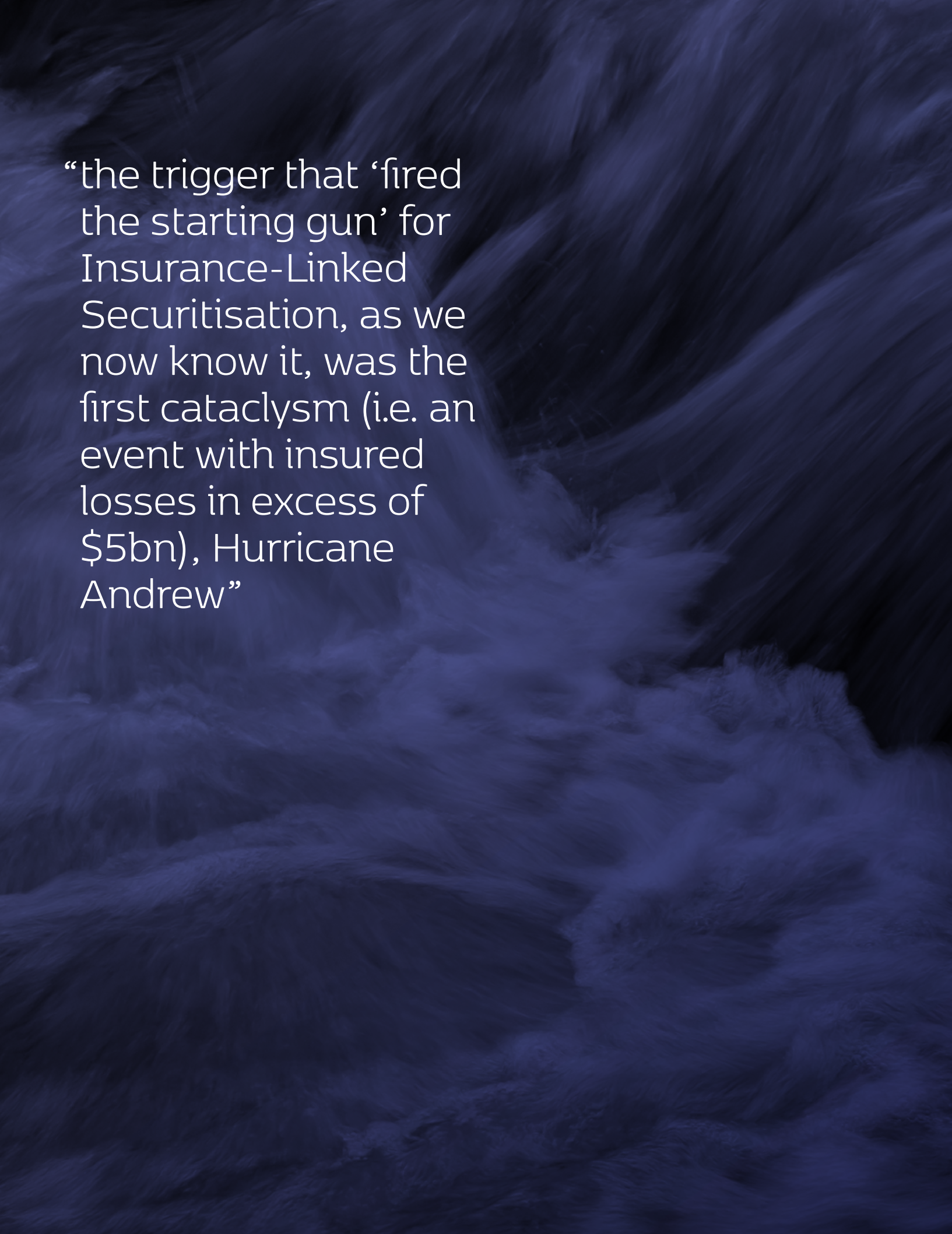
The primary reasons for writing this book are twofold. First, the 25-year anniversary seems an appropriate point to pause and take a retrospective view of what has been for me, and many others, a fascinating time to be part of the so-called 'convergence' movement, the bringing together of (re)insurance risk and capital market investors. Secondly, it is also timely, in the sense that many of the 'young Turks' that played a part in developing the ILS market are still to be found someplace around the ILS industry and hence were contactable to contribute some of their experiences and wisdom. I hope that this book conveys some of the challenges and achievements we all experienced through these pioneering years, and provides some fresh insights ("*new light through old windows*") to those old and new to the world of ILS.

In putting together this book I have drawn liberally on published sources and from conversations with some of those, now slightly older, 'Turks' who I encountered over my 25 years in the ILS-side of the (re)insurance industry (where appropriate I have credited them; some must for commercial reasons remain anonymous). My thanks to all those who have contributed, and in particular to Michael Millette (Founder and Managing Partner of Hudson Structured Capital Management) for his assistance and sponsorship, and to Steve Evans (Editor-in-Chief of Artemis.bm) for his website and events that keep the ILS community informed. But, as ever, any errors of fact or interpretation remain the responsibility of the author.

Alan Punter

London, July 2022

"Risk capital outstanding as at end 2021 was $37.75bn"

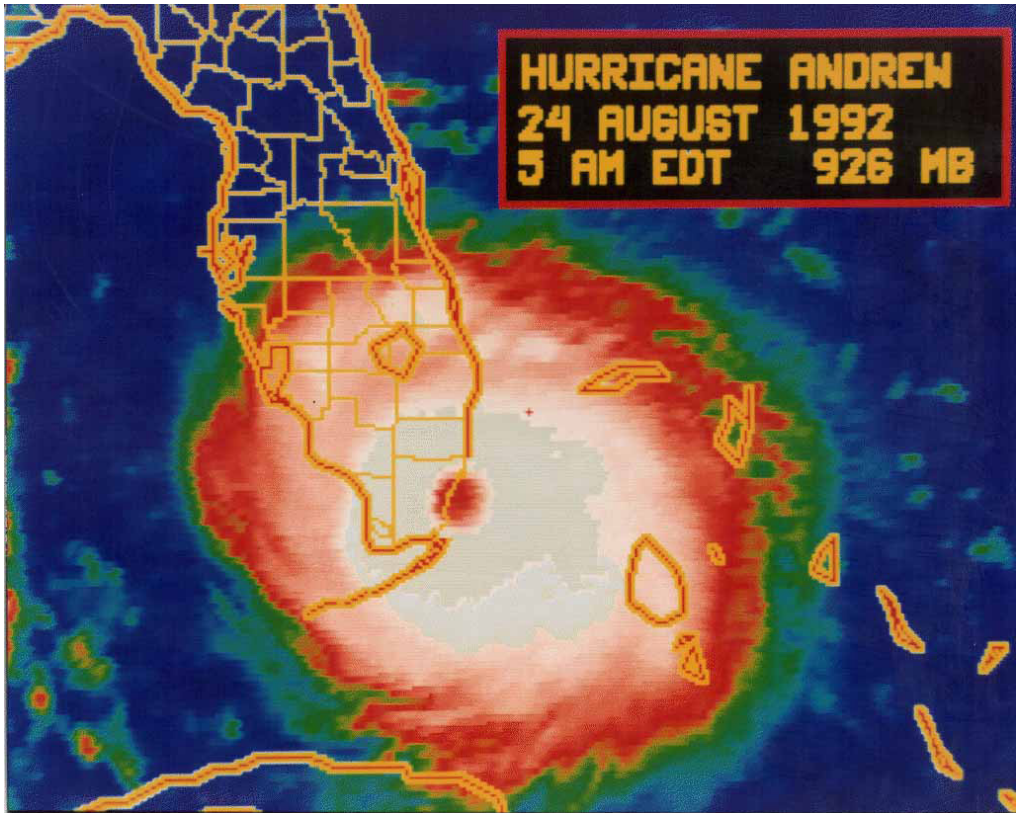


“the trigger that ‘fired the starting gun’ for Insurance-Linked Securitisation, as we now know it, was the first cataclysm (i.e. an event with insured losses in excess of $5bn), Hurricane Andrew”

The development of ILS

Before detailing the particular ILS structures, we will examine the reasons for their development. A number of market forces have led to their creation and growth over the past 25 years or so.

Some early innovative insurance and banking transactions took place over the period 1988 to 1992, such as the deferred acquisition costs under life insurance policies and reinsurance recoverables, and using financing such as conduits. However, the trigger that 'fired the starting gun' for Insurance-Linked Securitisation, as we now know it, was the first cataclysm (i.e. an event with insured losses in excess of $5bn), Hurricane Andrew making landfall in Miami-Dade County at around 5am on 24 August 1992[3].



Satellite image of Hurricane Andrew as it made landfall on the coast of Florida

The scale of potential insured losses from Hurricane Andrew jolted the industry and led to a coming together and convergence of various initiatives from risk modellers, academics, and investment bankers. The largest catastrophe losses prior to Hurricane Andrew had typically given rise to insured losses in the region of around $1bn, maybe with the exception of Hurricane Hugo in 1989 at nearer $4bn. To date, Hurricane Andrew is still the second largest insured loss in US history, exceeded only by Hurricane Katrina in 2005[4].

3 25th Anniversary of Hurricane Andrew, NOAA's Atlantic Oceanographic and Meteorological Laboratory, aoml.noaa.gov

4 Hurricane Andrew and Insurance: the enduring impact of an historic storm, Insurance Institute of America (IIA), August 2012

The forces leading to the development of ILS

Taking the contributions from these various sectors in turn:

A. Risk modelling

The first commercial hurricane catastrophe model was CATMAP. It was developed by Karen Clark, who founded Applied Insurance Research (AIR) and launched CATMAP in 1987. Four hours after Hurricane Andrew made landfall on 24 August 1992 near Homestead, Florida, AIR issued a statement that, using its US Hurricane Model, the insured losses could exceed $13bn in Florida[5]. This estimate, which was met with scepticism from the insurance industry at the time, was later validated by losses which turned out to be around $15bn in Florida (according to Property Claims Services® – PCS), and hence greatly increased interest in catastrophe modelling for estimating risk due to extreme events "almost overnight"[6].

B. Academics

The concept of transferring and trading (re)insurance risk in the capital markets goes back further than catastrophe risk modelling, and can be traced back as far as an academic paper co-authored in 1973 by Richard L. Sandor[7]. As a Professor on sabbatical from the University of California, Berkeley, Sandor took the post of Chief Economist and Vice-President at the Chicago Board of Trade (CBoT). There he pioneered the first interest rate futures contract, and amongst many others, the most widely traded interest-rate futures in the world, the US Treasury bond futures contract. Richard Sandor is widely regarded as the "father of financial futures"[8].

Preliminary work had been going on to devise insurance derivative contracts, but following Hurricane Andrew in August 1992, these efforts were fast-tracked and, under Richard Sandor's guidance, Morton Lane lead the origination of exchange-traded insurance futures contracts, which were launched on the CBoT on 25 September 1992[9]. The contracts were based on the composite combined loss ratio of 22 US insurance companies, including all classes of business (not just catastrophes), and were offered on various quarterly and annual, and regional and national bases. Despite considerable promotional efforts, reformulation of the contracts to options, and then basing them on PCS measures of catastrophe losses, trading in the CBoT insurance contracts never reached meaningful levels, and so the CBoT exchange-traded insurance contracts were withdrawn at the end of 1999[10].

The primary reason for the failure of these exchange-traded contracts was probably that there is no 'natural' counterparty for insurance risk. For any physical commodity (such as oil, wheat, etc.) there are parties with naturally opposing financial interest; if prices go up then producers gain and buyers suffer, and vice versa. So for exchange-traded commodity derivatives, there is a market made up of hedgers (producers and suppliers),

5 What Harvey and Irma say about the accuracy of catastrophe models, Carrier Management, Karen Clark, 16 October 2017

6 Wikipedia page on AIR Worldwide, as of 10 March 2021

7 Robert C. Goshay and Richard L. Sandor, "An Inquiry into the Feasibility of a Reinsurance Futures Market" Journal of Business Finance, Volume V (2), 1973

8 In more recent years Richard Sandor has led the convergence of financial markets and the environment, leading to Sandor also being named as the "Father of Carbon Trading"

9 Michael S. Canter, Joseph B. Cole and Richard L. Sandor, "Insurance Derivatives: A New Asset Class for the Capital Markets and a New Hedging Tool for the Insurance Industry" ISSN 1745-6622 Journal of Applied Corporate Finance, Fall 1997 (also published in the Journal of Derivatives, Winter 1996)

10 This is not unusual – one-third of new contracts do not make it to 2 years and the majority of new contracts are withdrawn within 10 years

plus speculators who help provide liquidity. Similarly for financial 'commodities' (such as stocks and shares, interest and exchange rates) there are parties with opposing financial interests; for example, if interest rates go up then lenders benefit and borrowers suffer, and vice versa – hence a marketplace of natural hedgers. However insurance losses are a 'one-sided' market - if insurance losses go up, then no-one benefits – there is no-one with a natural hedge, only potentially speculators, which does not seem sufficient to sustain a viable market.

"If insurance losses go up, then no-one benefits"

Several subsequent attempts to trade insurance risk on other exchanges have also failed to achieve meaningful success.

However, there is an active secondary market trading in catastrophe bonds.

C. Capital markets

One traditional response when the insurance industry has faced very large levels of losses or shortage of capacity in particular classes, has been to raise new equity and debt from the capital markets, both for existing (re)insurance companies and for the formation of new (re)insurance companies.

In response to the US liability crisis of the mid-1980s, ACE Limited was formed in 1985 in the Cayman Islands by a group of 34 US industrial corporations to provide difficult-to-obtain Excess Liability and Directors and Officers (D&O) insurance coverage. Shortly after EXEL (or X.L. Insurance more latterly) Limited was formed in 1986 in Barbados by 68 Fortune 500 companies to provide lower levels of Excess Liability coverage. Both ACE and EXEL were operating in Bermuda within a year of their formation, and so are regarded as the first Bermudian wave.

The second wave came in response to Hurricane Andrew in 1992. Over the following year, Bermuda saw ~$10.4bn of post-loss capital raised, comprising ~$8bn to recapitalise existing companies, and ~$2.4bn of start-up capital to form new property catastrophe reinsurance companies – including:

- Cat Ltd,
- Global Capital Re,
- IPC Re,
- La Salle Re,
- Mid Ocean Re,
- Partner Re,
- Renaissance Re, and
- Tempest Re

which have since become known as the Class of 1993.

The third wave followed the WTC event on 9 September 2001. Over the following year, this time Bermuda saw ~$16.2bn of post-loss capital raised, comprising ~$6bn of recapitalisation, ~$7.5bn of start-up capital to form new (re)insurance companies – including:

- Allied World,
- Arch Capital,
- Aspen,
- AXIS,
- Endurance Specialty,
- Max Re Capital,

- Montpelier Re, and
- Platinum Underwriters

naturally known as the Class of 2001. The total also included ~$2.2bn of capital raised by the issuance of catastrophe bonds, and a further ~$0.5bn of capital invested in sidecars.

The Hurricanes Charlie, Francis, Ivan and Jeanne in 2004 were followed by the worst year of insured hurricane losses in history in 2005 – principally Hurricanes Katrina, Rita and Wilma. Over the following year, ~$34.1bn of post-loss capital was raised in a fourth Bermudian wave, comprising ~$11.5bn of recapitalisation, and ~$11.0bn of start-up capital to form (re)insurance companies – including:

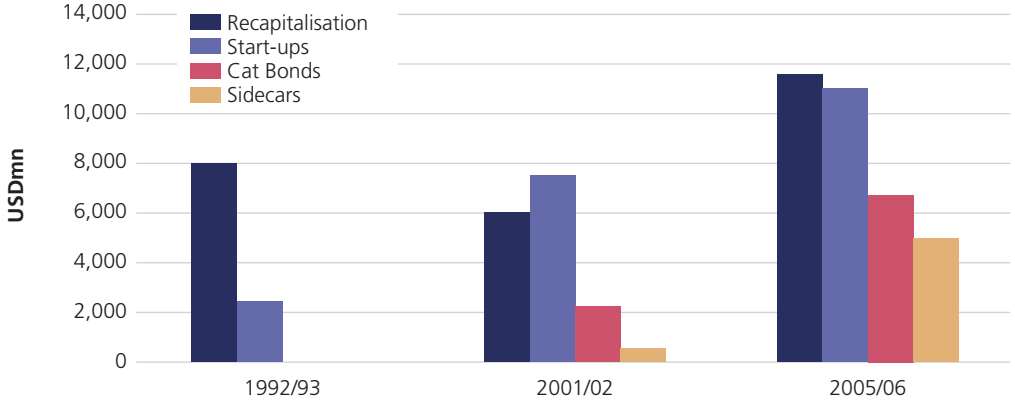
- Ariel Re,
- Flagstone Re,
- Harbour Point,
- Lancashire,
- New Castle Re, and
- Validus Re

naturally known as the Class of 2005 – plus some Lloyd's-related entities:

- Amlin Bermuda,
- Hiscox Bermuda, and
- Omega Specialty, Bermuda

The total also included ~$6.7bn of capital raised by the issuance of catastrophe bonds, and a further ~$4.9bn of capital invested in sidecars. Therefore, this total of ~$34.75bn of post-loss capital was more or less equally split three-ways between recapitalisation, start-ups and ILS structures (catastrophe bonds and sidecars).

The following chart illustrates the evolution of the shift in post-loss capital raising in Bermuda from 80% recapitalisation / 20% start-up in 1992/93 to more or less one-third each to recapitalisation, start-ups and ILS in 2005/06.



Post-loss capital raising by Bermudan companies

Source: Guy Carpenter, 13 November 2008

"This total of $34.75bn of post-loss capital was more or less equally split three ways between recapitalisation, start-ups and ILS structures"

D. Investment banks

The earliest insurance-linked securitisation is believed to date from 1988 – when Citibank completed two transactions to securitise the rights to future life insurance premium loadings, to be purchased by commercial paper-funded conduits – $75m for General American Life Insurance, and $30m for Washington National Life Insurance. Other early securitisations of life insurance were bank financing of the payment of agents' commissions on annuity sales, Citicorp $25m for Fidelity Benefit Life and Chase Manhattan $175m for Monarch Life. Prudential Insurance Company of America conducted a $445.6m private placement asset securitisation of policy loans. In 1989 Citibank conducted a $31.4m securitisation of annuity fees for Anchor National using conduit funding.

These early transactions can be characterised as 'insurance banking', the securitisation of insurance-linked **assets**, or insurance-linked financing, and were mainly concerned with advancing or deferring cash flows.

However, the first attempt to develop the securitisation of property catastrophe (underwriting) **risk**, or perhaps more correctly risk-linked securitisation, involving the transfer of risk, can be traced back to 1992. Merrill Lynch structured a $100m cat bond for AIG, to provide 3 years of cover for three risks: Florida hurricane, California earthquake, and Japanese earthquake. Losses under any one of the perils could lead to loss of principal, but no one peril could exhaust the capital. However, after the necessary securities documentation had been prepared, the bond was withdrawn (for unknown reasons[11]) before it was marketed to investors. Ironically, and probably to AIG's chagrin, this was just months before Hurricane Andrew in August 1992 and less than 2 years before the Northridge Earthquake in January 1994 – the two largest insured losses in history (up to that date) – and both events would have been covered under the proposed cat bond. Had this cat bond been placed, and investors taken a major hit to their principal, the subsequent history of cat bonds might have been somewhat different.

As it was, the first known successful securitisation of property catastrophe risk was in April 1996, when AIG Combined Risks in London (advised by Benfield Ellinger) issued $10m of cat bonds (paying Libor+795bps) through a SPV called Phoenix Re, providing one-year cover against catastrophe losses in any of five geographic regions. However, things really got started in the summer of 1996, when there were several major ILS property risk transactions being worked on by various investment banks developing new securitisation structures for clients, including:

1. **California Earthquake Authority (CEA)** was the biggest one, but the Earthquake Risk Bond (ERB) transaction proposed by Morgan Stanley, Goldman Sachs and Bear Sterns was not taken up by the CEA (this is described in detail as Deal 0 below).
2. **United Services Automobile Association (USAA)** is a mutual insurance company, and so could not raise equity. Merrill Lynch, Goldman Sachs and Lehman Bros worked on a more conventional bond structure, but could not get it fully placed, and so the bond was pulled. USAA subsequently issued its first cat bond, Residential Re in 1997, in what has since become a long series of cat bonds (this is described in detail under Deal 2 below).
3. **ACE Ltd** worked with Goldman Sachs on a more Industry Loss Warranty (ILW) style structure. This was sold, but subsequently collapsed over issues on indemnity and documentation.
4. **St Paul Re UK** worked with Goldman Sachs on the securitisation of a quota-share of a book of business, in a transaction named George Town Re. Marketing started

11 See Morton Lane in Alternative Risk Strategies, edited by Morton Lane, Risk Books, 2002, pages 634-635

on Labor Day 1996 and continued through August and September; in October the transaction had to be re-structured and was re-marketed through November and then finally priced at 4pm on 23 December 1996 (this transaction is dealt with below as Deal 1). The securitisation of insurance risk, as we now recognise it, on a meaningful scale had started.

So it was this conjunction of risk modelling of catastrophes, academic attempts to make insurance risk tradable, the availability of capital markets, and investment banks devising securitisation structures, that was kick-started by Hurricane Andrew and its aftermath that was the true beginning of Insurance-Linked Securitisation (ILS) as we know it now. This can be regarded as a case of demand (or capital shortage) meeting supply (or capital availability), and investment bankers acting as the facilitators.

Demand

Hurricane Andrew hit Florida in August 1992, and as mentioned previously, the initial estimates of the total insured cost in the region of $15bn to $16bn were a significant step up from previous major natural catastrophe losses. On top of this, one catastrophe modelling company, RMS, produced a report that estimated if Hurricane Andrew had passed through Miami (rather than missing it by around 50 miles), the insured losses would have been nearer $50bn. Also, at around the same time, further RMS reports estimated that a repeat of the 1906 San Francisco earthquake, but with current day (as at early 1990s) insured values, would cost around $70bn to $110bn; and a major earthquake centred on Los Angeles would cost around $80bn to $120bn. And a major flood in Texas could give rise to some $40bn of insured losses. All of a sudden the US (re)insurance industry was looking at the potential for three catastrophe losses (a hurricane hitting Miami, a flood in Texas and an earthquake in California) giving rise to a total of around $200bn of insured losses – and it was not inconceivable that all three catastrophes could happen on the same day. What was scarier was that the total capital of the US insurance industry at the time was estimated to be around $225bn, with only another $25bn by way of reinsurance – and this capital would have to pay any variation in the much greater total of 'normal' property and casualty losses, not just property catastrophe losses[12]. It became abundantly clear that the (re)insurance industry could one day need access to a new, greater source of risk capital in order to survive.

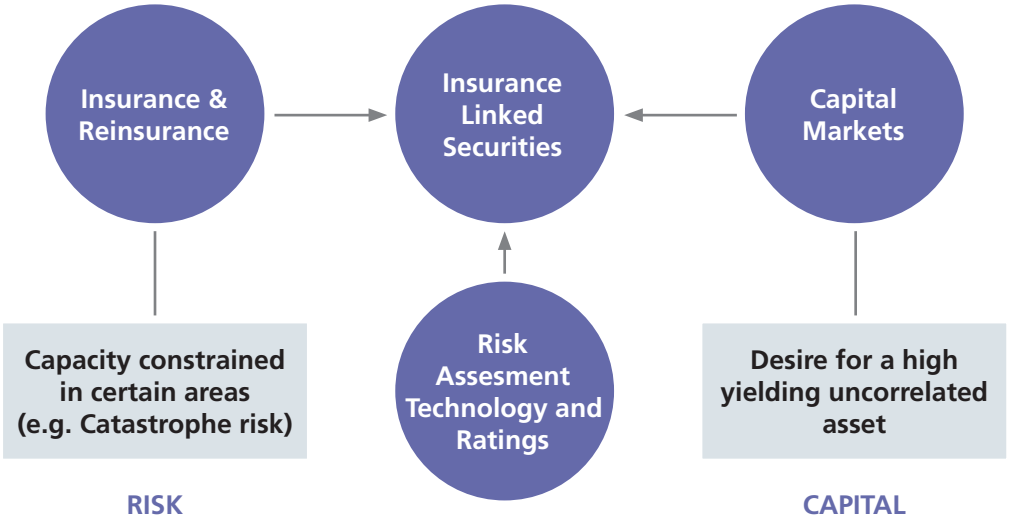
Supply

The most obvious source to find this additional capital was the capital markets. At the time the 95% Value-at-Risk (VaR) on Wall Street was around $125bn (on the $19tn US securities markets) – in other words about one day in twenty (about once a month in terms of trading days) the total value of stocks traded on Wall Street could be expected to fall by around $125bn[13] – and it would not be a catastrophe in stock market terms, but just 'normal' variation. Wall Street had much deeper pockets of risk capital, and could sustain a level of losses that would otherwise threaten the very future of the (re) insurance industry.

The answer lay in finding a way to match this demand for new capital (because of the potential catastrophic insured losses) with this supply of risk capital on Wall Street – leading to the so-called convergence of insurance and the capital markets, as shown in the following diagram.

12 And as Richard Sandor pointed out, in such a mega-catastrophic situation, there would be second-order systemic effects on the markets and economy, with (re) insurance companies liquidating their investment portfolios, disrupting bond markets, etc. [see Alternative (Re)insurance Strategies, 2nd edition, edited by Morton Lane, page 27]

13 Andrew Alper noted that "there is a difference between realized losses and trading losses, but volatility is something that the {capital} markets can handle" in The Financing of Catastrophe Risk, edited by Kenneth A. Froot, University of Chicago Press, 1999, page 441



Source: "Convergence of insurance and capital markets", World Economic Forum, Oct. 2008

Despite the apparent unattractiveness of natural catastrophe (re)insurance risk to investors from the capital markets, two main factors combined to make such convergence possible.

First, the growing ability to model and quantify insurance catastrophe risk:

a. The computer models for natural perils (primarily at that stage, US hurricanes and earthquakes) were able to produce an objective measurement of the underwriting risk. Coupled with this, the credit rating agencies were able to give ratings to many of the early ILS structures.

b. Then, for a given level of credit risk, ILS structures paid a higher 'premium' than the coupon on similarly rated traditional capital market investment (such as corporate or municipal bonds).

Secondly, the nature of (re)insurance underwriting risk. The returns on ILS structures are typically uncorrelated with other capital market investments. Most capital market investments are to some degree correlated – the price performance of shares, bonds, property and other investment opportunities are broadly correlated with economic prospects in general and interest rates in particular. Meanwhile returns linked directly to (re)insurance risk (particularly property catastrophe losses) are not correlated with capital market investments – significant movements in the economy do not cause hurricanes and earthquakes, nor vice versa – hence, according to modern portfolio investment theory, (re)insurance underwriting risk is said to have low or zero-beta characteristics (i.e. low or zero-correlation with investment market movements). Modern portfolio investment theory says that the inclusion of some higher yielding, low beta instruments (such as ILS structures) in an investment portfolio actually improves the overall risk-return performance of the portfolio – either yielding a greater expected return but with the same level of risk, or looking at it another way, yielding the same expected return but at a lower level of risk. This reasoning has proved convincing in getting institutional investors from the capital markets to participate in various ILS structures.

Catastrophe bonds – Ancient & Modern

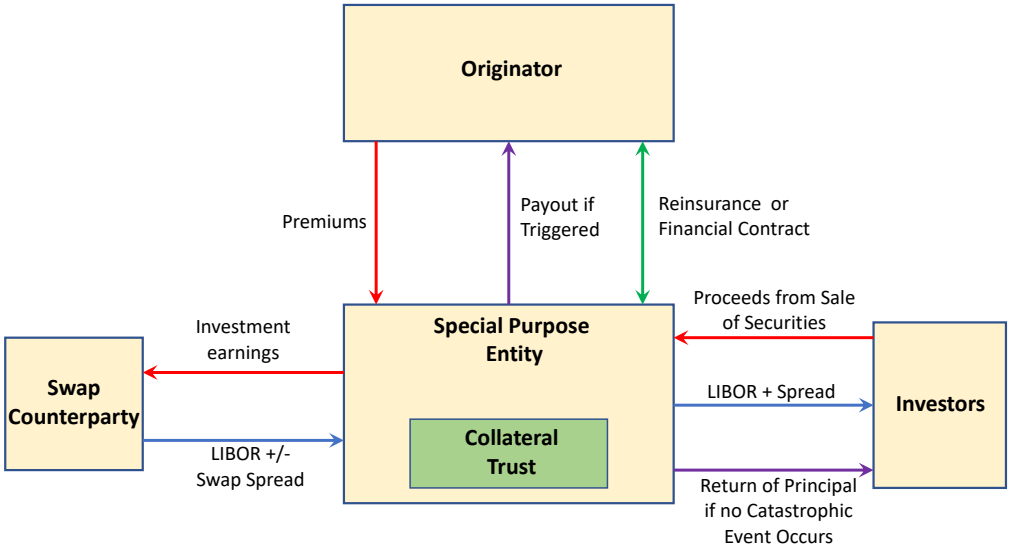
A. Ancient – Code of Hammurabi (c. 2100 BC) and bottomry

Arguably catastrophe bonds are not just 25 years old, but over 4,000 years old. The Babylonian Code of Hammurabi (c. 2100 BC) included a form of bottomry – the insurance of a merchant ship's 'bottom' (i.e. hull). Under the Babylonian form of bottomry a loan would be advanced to fit out a ship and/or purchase cargo for a voyage, but repayment would be contingent on the ship successfully completing the voyage; under this arrangement a higher-than-normal rate of interest could be charged on the loan, 'marine interest'. The feature that the lender can lose the principal of the loan is akin to investors purchasing a cat bond, and the higher rate of interest is akin to the risk premium paid by a cat bond.

B. Modern – basic structure of a contemporary cat bond

Most cat bonds are constructed based on the following structure. A Special Purpose Vehicle (SPV) or Reinsurer (SPR) is formed as a reinsurance company, typically in the earlier years in the Cayman Islands, but more recently other domiciles have been used, particularly Bermuda (but also Dublin, London and Singapore have the appropriate legislation). The SPR then raises capital by issuing securities (or notes or bonds) to investors, the proceeds of which are placed in a Collateral Trust; the variable investment earnings on this Trust are fixed by entering into a total return swap with a Counterparty. The SPR then writes a reinsurance contract on behalf of the Sponsor (or Originator) with the same limit as collateralised by the funds raised by the notes. Investors in the notes receive regular dividends (or coupons) and then full or partial repayment of principal at maturity, subject to any qualifying losses incurred under the reinsurance contract with the Sponsor and paid by the SPR.

A Typical Catastrophe Bond Structure



Source: Issues Paper on Non-Life Securitisation, International Association of Insurance Supervisors (IAIS), October 2003

Cat bonds covering primarily property catastrophe risks

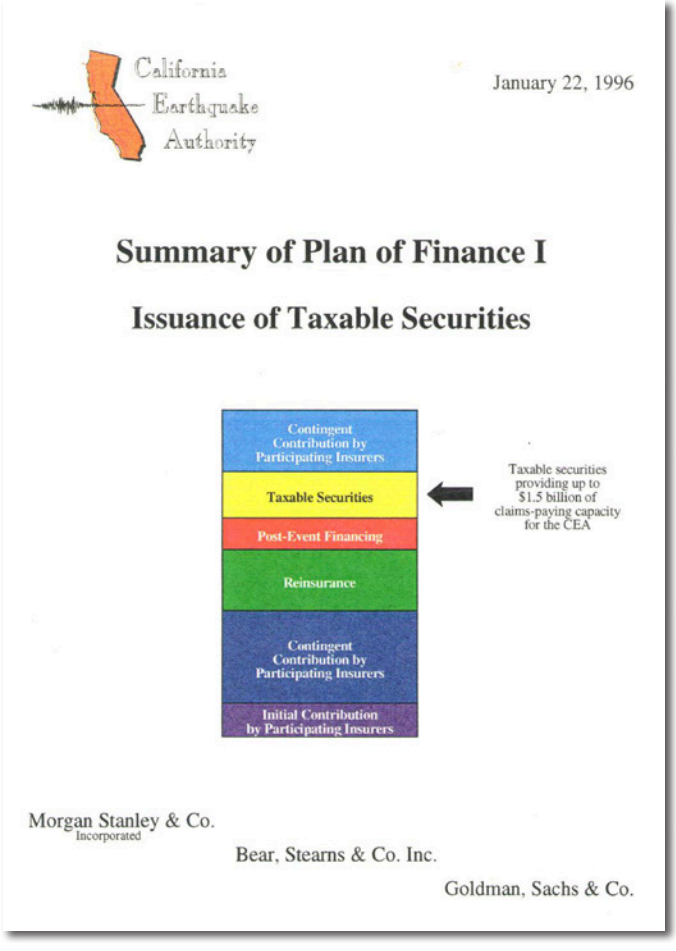
A

The great majority of cat bonds (often called 'Act-of-God' bonds in the earlier years) issued over the past 25 years have provided cover against natural catastrophe risks. This section reviews some of the ground-breaking or landmark property catastrophe risk transactions – typically the first cat bond to introduce a new structural feature, or a new trigger mechanism, or to be issued by a new class of sponsor. For convenience and consistency we will, as far as possible, use the naming of cat bond SPVs and Sponsors as given on the www.artemis.bm website, under the "Deal Directory - Cat Bonds & ILS" tag.

Deal 0: Earthquake Risk Bonds (1996) / California Earthquake Authority – the 'ground breaking' cat bond proposal

[Morgan Stanley; Bear, Sterns; Goldman, Sachs]

The first landmark 'deal' was the Earthquake Risk Bonds (ERB) proposed to the California Earthquake Authority (CEA) in January 1996. We have labelled it as Deal 0, because the CEA did not proceed with the structure proposed jointly by Morgan Stanley, Bear Stearns and Goldman Sachs. The importance of this proposal is that it developed the basic bond structure that underpinned the early development of cat bonds.



Structure: The proposal was for the "Issuance of Taxable Securities" (known as ERBs), to be sold to institutional investors, that would provide up to $1.5bn of claims-paying capacity for the CEA, that would form one layer in the tower of risk transfer and risk financing of CEA's capital resources. In this early structure the purchasers of ERBs would be fully secured as to the return of their principal investment in ERBs, but the coupon payment on these ERBs would be fully or partially at risk subject to the risk of losses incurred by the CEA from California earthquakes.

It was proposed that, depending on market conditions at the time of issue, around $3.55bn of 10-year ERBs would be issued, yielding Libor+1075bps. Of these proceeds, $2.05bn would be immediately re-invested in 10-year US Treasury Strips (or zero-coupon bonds), to provide on maturity a sum sufficient to repay the full $3.55bn of principal to ERB investors. The remaining $1.5bn of capital raised ($3.55bn less than the $2.05bn invested in US Treasury Strips) would be available as risk capital to pay losses, with any unused risk capital available to make coupon payments on the ERBs. This $1.5bn of capital (and hence any coupon payment) was at risk over a three-to-four-year period. To stabilise the earthquake risk profile faced by investors from year to year, the covered losses

would be defined on an annual aggregate basis, with the annual trigger linked to the annual in-force premium earned by the CEA on earthquake policies.

The proposal noted that, given the novelty of issuing ERBs, a lengthy and intense period of marketing would be needed, along with an extensive investor education program about earthquake risk and the scientific modelling of earthquake loss distributions.

Finally, it was stated that no specific restrictions on the transfer of ERBs between investors (subsequent to the initial sale of the securities at issue) would be imposed. The ability to trade cat bonds on the secondary market is one of the fundamental differences between (re)insurance policies (non-transferable) and cat bonds (tradable securities).

Outcome: Although the CEA decided not to take up the ERB proposal, the trio of investment banks had done the 'heavy-lifting' of devising a structure to package insurance catastrophe risk into marketable securities that could appeal to institutional investors. However, the CEA decided instead to purchase a traditional reinsurance policy from Berkshire Hathaway, providing the equivalent $1.5bn cover over a three-to-four-year period. The reported premium for this policy was $590m.

The CEA did subsequently issue a number of cat bonds, starting with Western Capital (2001), a $100m bond (see Deal 7 below).

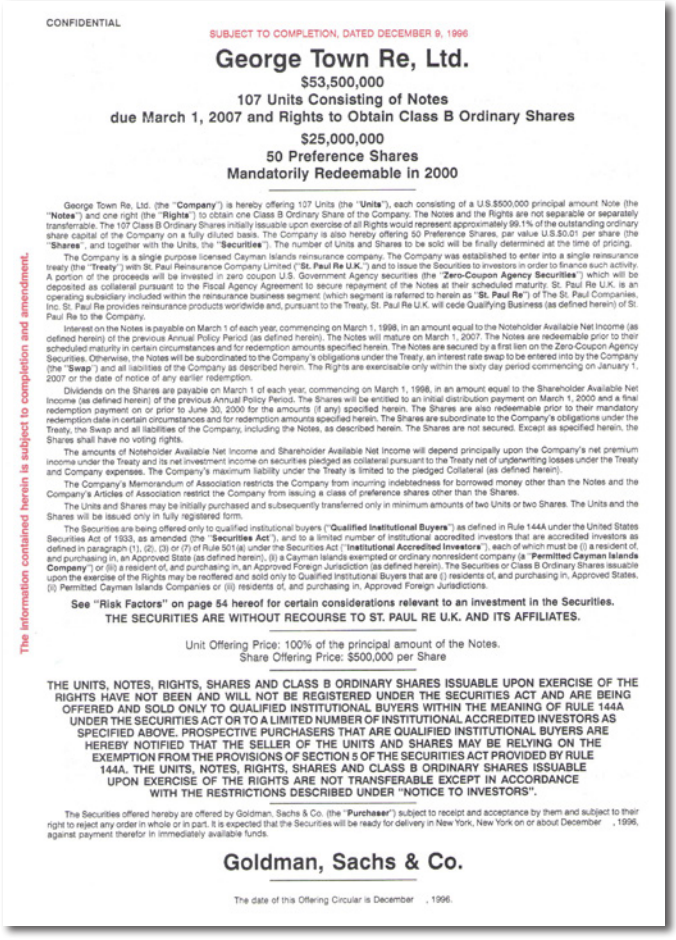
Deal 1: George Town Re (1996) / St Paul Re UK – the first broadly distributed cat bond/sidecar credit-rated transaction

[Structuring & placement: Goldman Sachs]

Structure: George Town Re was formed and authorised as a single purpose reinsurance company in the Cayman Islands. St Paul Re UK then ceded a quota share of its excess of loss property reinsurance treaty to George Town Re on a 10-year basis (an unusually long period by reinsurance industry standards). George Town Re provided $10m of limit on each of five short-tail excess-of-loss reinsurance classes of business: (1) US/Caribbean property-casualty, (2) European property-casualty, (3) other property-casualty, (4) retrocessional/Lloyd's short tail, and (5) marine & aviation. It was warranted that George Town Re's proportion of any risk would always be equal to, or less than, St Paul Re's own net (of all proportional reinsurance) share. The purpose of the transaction was to use the capital markets to increase St Paul Re's capacity by about 50% to write business across these five classes.

George Town Re was funded in December 1996 by Goldman Sachs raising $68.5m through a private placement, comprising:

- $44.5m of 10-year debt notes expiring in 2007, on which interest was payable; between $23.2m and $24.2m of these notes were invested at inception in US Treasury (zero-coupon) bonds for a 10-year period, thereby guaranteeing the return of the noteholders' original capital



CONFIDENTIAL

SUBJECT TO COMPLETION, DATED DECEMBER 9, 1996

George Town Re, Ltd.

$53,500,000
107 Units Consisting of Notes
due March 1, 2007 and Rights to Obtain Class B Ordinary Shares

$25,000,000
50 Preference Shares
Mandatorily Redeemable in 2000

George Town Re, Ltd. (the "**Company**") is hereby offering 107 Units (the "**Units**"), each consisting of a U.S.$500,000 principal amount Note (the "**Notes**") and one right (the "**Rights**") to obtain one Class B Ordinary Share of the Company. The Notes and the Rights are not separable or separately transferable. The 107 Class B Ordinary Shares initially issuable upon exercise of all Rights would represent approximately 99.1% of the outstanding ordinary share capital of the Company on a fully diluted basis. The Company is also hereby offering 50 Preference Shares, par value U.S.$0.01 per share (the "**Shares**", and together with the Units, the "**Securities**"). The number of Units and Shares to be sold will be finally determined at the time of pricing.

The Company is a single purpose licensed Cayman Islands reinsurance company. The Company was established to enter into a single reinsurance treaty (the "**Treaty**") with St. Paul Reinsurance Company Limited ("**St. Paul Re U.K.**") and to issue the Securities to investors in order to finance such activity. A portion of the proceeds will be invested in zero coupon U.S. Government Agency securities (the "**Zero-Coupon Agency Securities**") which will be deposited as collateral pursuant to the Fiscal Agency Agreement to secure repayment of the Notes at their scheduled maturity. St. Paul Re U.K. is an operating subsidiary included within the reinsurance business segment (which segment is referred to herein as "**St. Paul Re**") of The St. Paul Companies, Inc. St. Paul Re provides reinsurance products worldwide and, pursuant to the Treaty, St. Paul Re U.K. will cede Qualifying Business (as defined herein) of St. Paul Re to the Company.

Interest on the Notes is payable on March 1 of each year, commencing on March 1, 1998, in an amount equal to the Noteholder Available Net Income (as defined herein) of the previous Annual Policy Period (as defined herein). The Notes will mature on March 1, 2007. The Notes are redeemable prior to their scheduled maturity in certain circumstances and for redemption amounts specified herein. The Notes are secured by a first lien on the Zero-Coupon Agency Securities. Otherwise, the Notes will be subordinated to the Company's obligations under the Treaty, an interest rate swap to be entered into by the Company (the "**Swap**") and all liabilities of the Company as described herein. The Rights are exercisable only within the sixty day period commencing on January 1, 2007 or the date of notice of any earlier redemption.

Dividends on the Shares are payable on March 1 of each year, commencing on March 1, 1998, in an amount equal to the Shareholder Available Net Income (as defined herein) of the previous Annual Policy Period. The Shares will be entitled to an initial distribution payment on March 1, 2000 and a final redemption payment on or prior to June 30, 2000 for the amounts (if any) specified herein. The Shares are also redeemable prior to their mandatory redemption date in certain circumstances and for redemption amounts specified herein. The Shares are subordinate to the Company's obligations under the Treaty, the Swap and all liabilities of the Company, including the Notes, as described herein. The Shares are not secured. Except as specified herein, the Shares shall have no voting rights.

The amounts of Noteholder Available Net Income and Shareholder Available Net Income will depend principally upon the Company's net premium income under the Treaty and its net investment income on securities pledged as collateral pursuant to the Treaty net of underwriting losses under the Treaty and Company expenses. The Company's maximum liability under the Treaty is limited to the pledged Collateral (as defined herein).

The Company's Memorandum of Association restricts the Company from incurring indebtedness for borrowed money other than the Notes and the Company's Articles of Association restrict the Company from issuing a class of preference shares other than the Shares.

The Units and Shares may be initially purchased and subsequently transferred only in minimum amounts of two Units or two Shares. The Units and the Shares will be issued only in fully registered form.

The Securities are being offered only to qualified institutional buyers ("**Qualified Institutional Buyers**") as defined in Rule 144A under the United States Securities Act of 1933, as amended (the "**Securities Act**"), and to a limited number of institutional accredited investors that are accredited investors as defined in paragraph (1), (2), (3) or (7) of Rule 501(a) under the Securities Act ("**Institutional Accredited Investors**"), each of which must be (i) a resident of, and purchasing in, an Approved State (as defined herein), (ii) a Cayman Islands exempted or ordinary nonresident company (a "**Permitted Cayman Islands Company**") or (iii) a resident of, and purchasing in, an Approved Foreign Jurisdiction (as defined herein). The Securities or Class B Ordinary Shares issuable upon the exercise of the Rights may be reoffered and sold only to Qualified Institutional Buyers that are (i) residents of, and purchasing in, Approved States, (ii) Permitted Cayman Islands Companies or (iii) residents of, and purchasing in, Approved Foreign Jurisdictions.

See "Risk Factors" on page 54 hereof for certain considerations relevant to an investment in the Securities.
THE SECURITIES ARE WITHOUT RECOURSE TO ST. PAUL RE U.K. AND ITS AFFILIATES.

Unit Offering Price: 100% of the principal amount of the Notes.
Share Offering Price: $500,000 per Share

THE UNITS, NOTES, RIGHTS, SHARES AND CLASS B ORDINARY SHARES ISSUABLE UPON EXERCISE OF THE RIGHTS HAVE NOT BEEN AND WILL NOT BE REGISTERED UNDER THE SECURITIES ACT AND ARE BEING OFFERED AND SOLD ONLY TO QUALIFIED INSTITUTIONAL BUYERS WITHIN THE MEANING OF RULE 144A UNDER THE SECURITIES ACT OR TO A LIMITED NUMBER OF INSTITUTIONAL ACCREDITED INVESTORS AS SPECIFIED ABOVE. PROSPECTIVE PURCHASERS THAT ARE QUALIFIED INSTITUTIONAL BUYERS ARE HEREBY NOTIFIED THAT THE SELLER OF THE UNITS AND SHARES MAY BE RELYING ON THE EXEMPTION FROM THE PROVISIONS OF SECTION 5 OF THE SECURITIES ACT PROVIDED BY RULE 144A. THE UNITS, NOTES, RIGHTS, SHARES AND CLASS B ORDINARY SHARES ISSUABLE UPON EXERCISE OF THE RIGHTS ARE NOT TRANSFERABLE EXCEPT IN ACCORDANCE WITH THE RESTRICTIONS DESCRIBED UNDER "NOTICE TO INVESTORS".

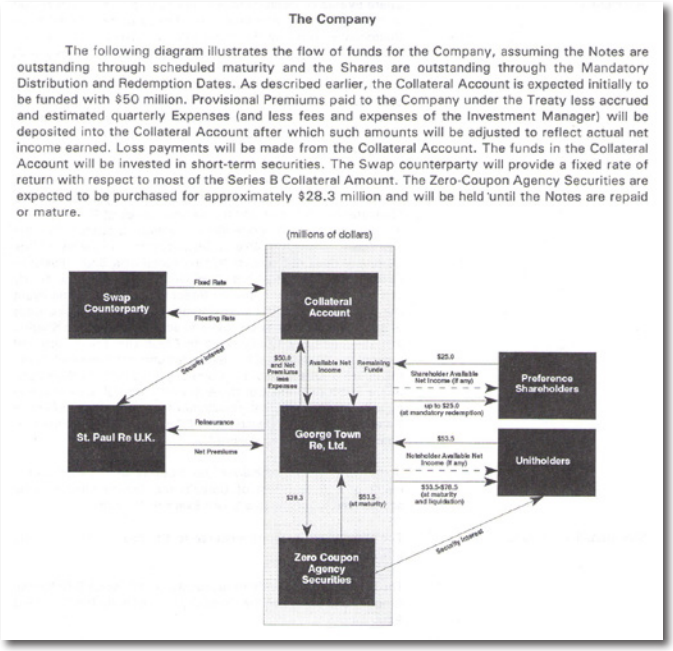
The Securities offered hereby are offered by Goldman, Sachs & Co. (the "**Purchaser**") subject to receipt and acceptance by them and subject to their right to reject any order in whole or in part. It is expected that the Securities will be ready for delivery in New York, New York on or about December , 1996, against payment therefor in immediately available funds.

Goldman, Sachs & Co.

The date of this Offering Circular is December , 1996.

The information contained herein is subject to completion and amendment.

- $24m of 3-year equity in the form of preferred shares redeemable in 2000, when dividends and repayment of capital (dependent on the underwriting performance of George Town Re) would be payable
- The $50m of funds not invested in US Treasury bonds were used to establish a fully collateralised account to secure payment of George Town Re's claims obligation under the reinsurance treaty



Structure of George Town Re

Source: George Town Re Offering Circular

[NB: this diagram anticipates the issuance of $53.5m of notes and $25m of equity, rather than the final completion figures of $44.5m and $24m respectively.]

Because of the various possible maturities (at the end of 3-years, or 10-years, or any earlier cancellation), certain close-out provisions had to be written into the reinsurance treaty to allow crystallisation of George Town Re's profits and hence the corresponding redemption of the shares and/or notes. As with most of the subsequent cat bond issuances, the formation and management of the special purpose vehicle and the investment of its funds required a variety professional services, including investment bankers, insurance and financial analysts, risk modelling companies, lawyers, insurance company managers, investment managers, and credit rating agencies.

Losses: George Town Re made a series of small loss payments, totalling around $0.5m, as a result of St Paul Re UK incurring some qualifying losses in 1999 due to Hurricane Floyd and some other windstorms, losses in 2000 due to UK floods, and losses in 2001 due the World Trade Centre event.

Deal 2: Residential Reinsurance (1997) & USAA – the first major indemnity cat bond

[Structuring & placement: Merrill Lynch, Goldman Sachs, Lehman Brothers]

Although not the very first cat bond, Residential Re (1997) was the first major cat bond issuance by an insurance company.

Structure: Residential Reinsurance was an SPV, formed and domiciled in the Cayman Islands, to facilitate a private placement of $477m of bonds. The bonds were issued in two tranches:

- Class A-1 $164m of principal-protected bonds, yielding Libor+273bps
- Class A-2 $313m of principal-at-risk bonds, yielding Libor+576bps

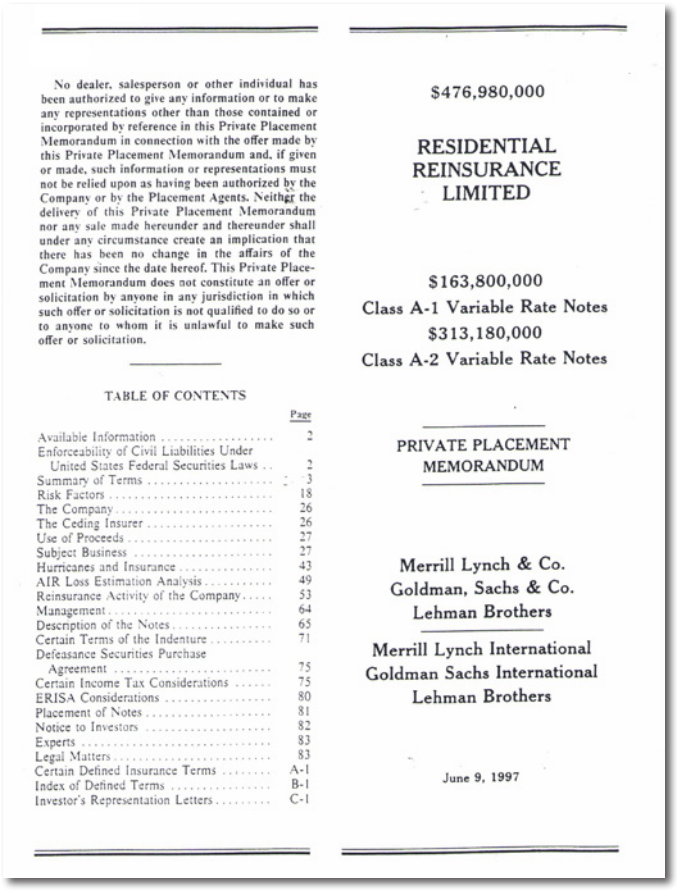
The Class A-1 principal-protected bonds used the same technology as the proposed CEA ERBs; $77m of the proceeds would be re-invested in 10-year zero-coupon bonds to generate $164m at maturity; the other $87m (i.e. $164m less $77m) of the Class A-1 proceeds, together with the $313m of Class A-2 bonds, would provide a total of $400m of claims-paying ability.

Residential Reinsurance provided USAA with $400m of indemnity for one year, covering 80% of USAA's losses in the layer $500m excess of $1bn. The trigger was a single East Coast hurricane of intensity 3, 4 or 5 – in the event of more than one such hurricane

during the 1-year policy period, USAA could choose which hurricane to claim against. Unlike a reinsurance policy, there is no re-instatement of limit (for a second or further events) should there be a partial or full loss first event (a key feature of all cat bonds).

Four specific features of this first Residential Reinsurance issuance are particularly worthy of note.

1. **A principal-protected tranche.** The principal-protected A-1 tranche was included because it was believed that some institutional investors would be prevented, by mandate or by inclination, to invest in principal-at-risk bonds. However the response of investors was so positive, the issue was over-subscribed by a factor of 2plus, that very few subsequent cat bonds included a principal-protected tranche.
2. **Credit rating.** S&P rated the A-1 tranche 'AAA' and the A-2 tranche 'BB'. The use of catastrophe modelling, together with obtaining credit ratings from recognised bond rating agencies, were critical components in giving early capital market bond investors comfort that the structure and pricing of the cat bonds were sound and compared favourably to other government and corporate bonds in the market.
3. **Co-insurance.** The co-insurance element in the structure of the indemnity cover was included to give institutional investors, new to ILS cat bonds, the comfort that USAA would be retaining 20% of any losses in the layer $500m excess of $1bn, and so USAA retained an incentive to minimise the total cost of claims (a co-insurance clause not being uncommon in reinsurance policies). Otherwise there was the possible moral hazard that USAA, once paid losses reached $1bn, would pay all claims regardless because 'it was someone else's money'. Again this co-insurance feature was soon dropped in subsequent cat bond issuances, as investors became comfortable with the operation of cat bonds.
4. **Motivation.** USAA acknowledged that the cost of the cover provided by Residential Reinsurance was more expensive than they could have obtained under an equivalent conventional reinsurance policy. The reasons for issuing a cat bond were strategic; diversifying the source of reinsurance protection and proving the concept of opening up access to a new source of risk capital (should the traditional reinsurance market ever experience a capacity squeeze at some future date).



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$476,980,000

RESIDENTIAL REINSURANCE LIMITED

$163,800,000
Class A-1 Variable Rate Notes
$313,180,000
Class A-2 Variable Rate Notes

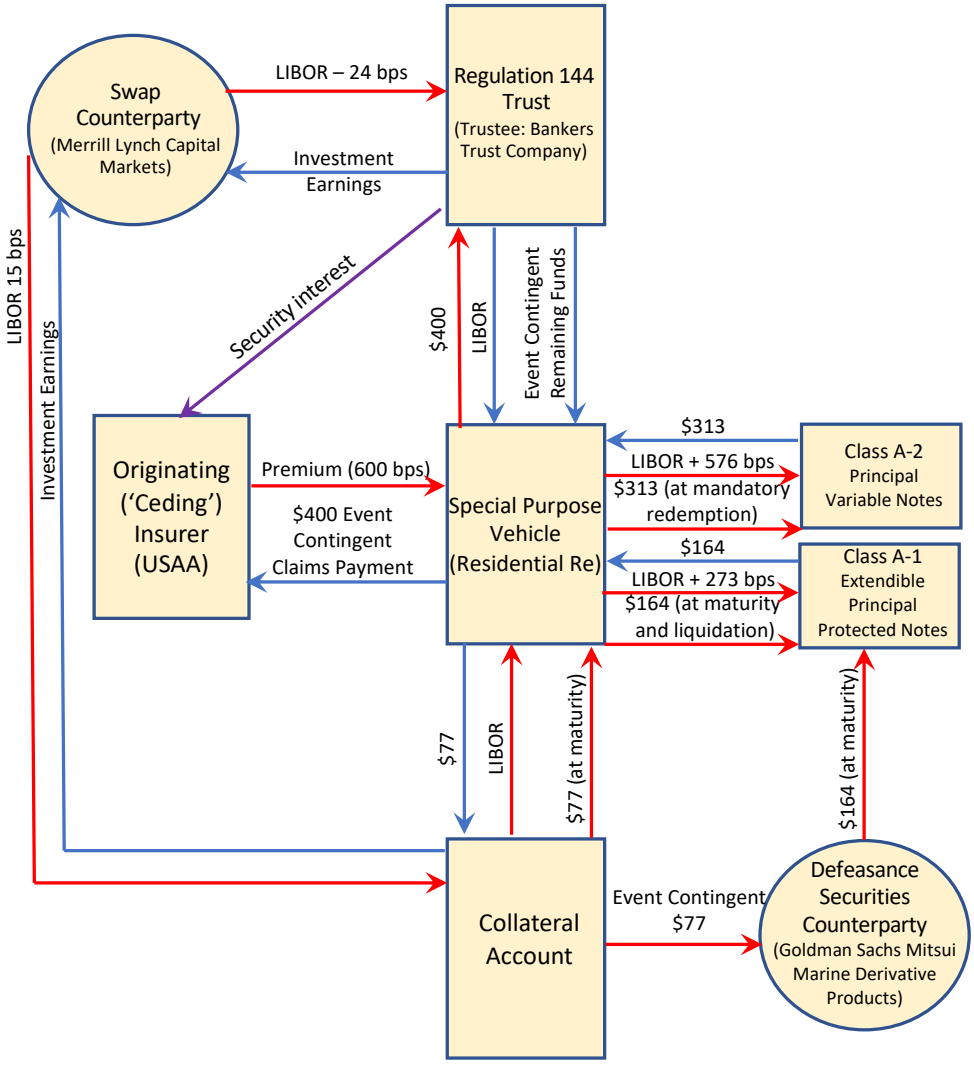
PRIVATE PLACEMENT MEMORANDUM

Merrill Lynch & Co.
Goldman, Sachs & Co.
Lehman Brothers

Merrill Lynch International
Goldman Sachs International
Lehman Brothers

June 9, 1997

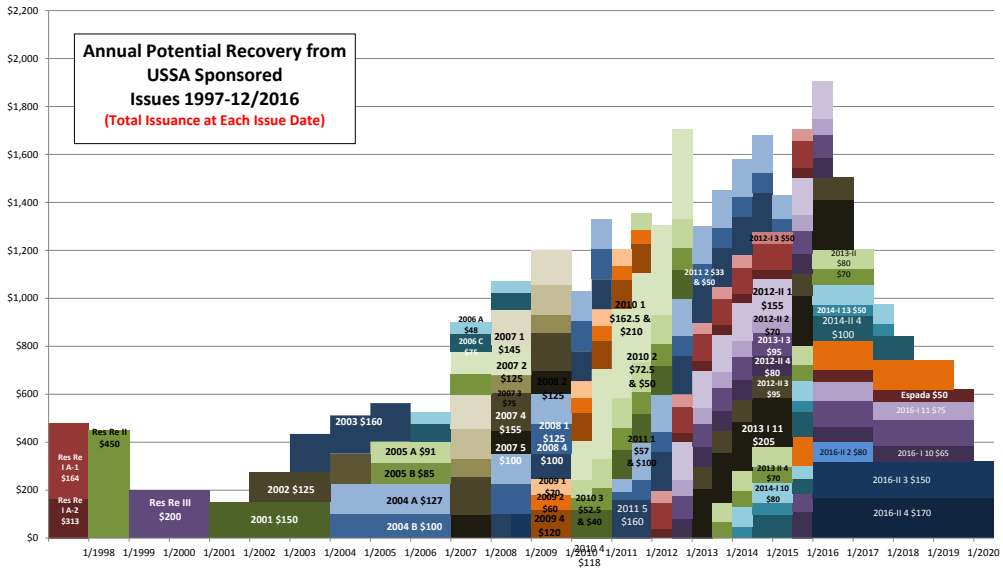
The Residential Re Transaction



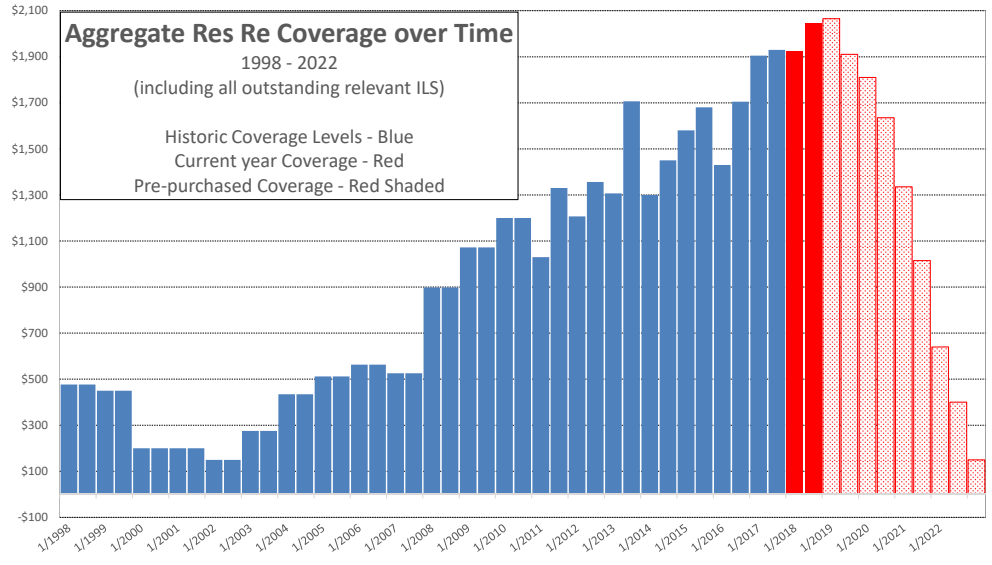
Source: Issues Paper on Non-Life Securitisation, International Association of Insurance Supervisors (IAIS), October 2003

Outcome: USAA has since become the most frequent insurance company issuer of cat bonds, as a regular part of its reinsurance programme, issuing one or more cat bonds every year since 1997. By the end of June 2022 USAA had issued 39 cat bonds, raising a total of $9.736bn of indemnity risk capital – an average of $250m per bond. The structure and coverage of these bonds have evolved over the years. Residential Reinsurance (1997) was a single event, 1-year, catastrophe occurrence bond; subsequent bonds have become multi-year (typically 3-years or 4-years), often covering two or more classes, sometimes with a class annual aggregate, and increasingly covering non-catastrophe layers. The eight Residential Reinsurance cat bonds issued since November 2018 have each provided multi-year protection for a wide range of perils, including covering US tropical cyclones, earthquakes (plus fire following), severe thunderstorm, winter storm, wildfire, volcanic eruption, meteorite impact and other perils (including auto and renter policy flood losses).

The cumulative coverage provided to USAA by successive cat bond issues



Source: Annual Review for the four quarters Q2 2016 to Q1 2017, Lane Financial LLC, March 2017



Source: Annual Review for the four quarters Q2 2018 to Q1 2019, Lane Financial LLC, March 2019

Loss experience: The Residential Reinsurance bonds ran loss free until 2017, when Hurricanes Harvey & Irma, California wildfires and winter storms partially or fully impaired various tranches in a number of bonds, and then in 2018 Hurricanes Florence & Michael, California wildfires, and convective weather & tornadoes caused a total loss to one tranche of another Residential Reinsurance bond. However this is partly explained by the evolution in the bonds placed by USAA over the years. The bonds issued in the first couple of years were 'catastrophe' bonds, having expected losses of around 1%; in more recent years, whilst some provide catastrophe level cover, others have been placed at more excess-like layers (in each of the last five years, one of the tranches has had an expected loss of over 15%).

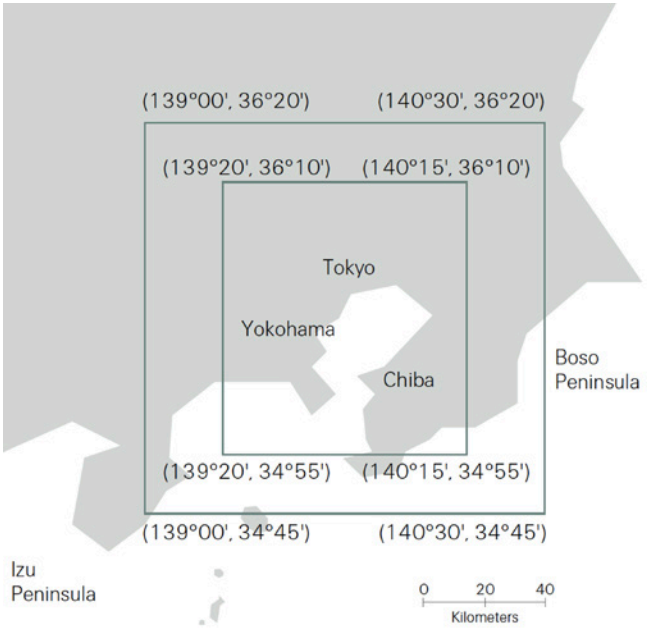
Deal 3: Parametric Re (1997) / Tokio Marine & Nichodo Fire Insurance – the first non-indemnity cat bond

[Structuring & placement agents: Swiss Re Capital Markets, Goldman Sachs; Risk modelling: EQE International]

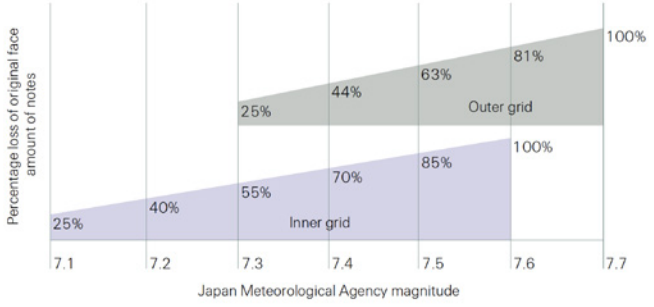
As signified in the name of the SPV created for this deal, Parametric Re, this cat bond was the first with a parametric, i.e. non-indemnity, structure.

Structure: Parametric Re was a 10-year $100m bond in two tranches (rated 'Ba2' and 'Baa3' by Moody's). The loss trigger was any earthquake within a defined area around Tokyo that registered M7.1 or above on the Mercalli scale. The size of the loss payment was then defined by a sliding scale depending on how much above the M7.1 trigger the earthquake event was.

The bond covered multiple events (up to the $100m in aggregate over 10 years), but with a limit of one event per 30 days (to help eliminate the problem of aftershocks).



Key feature: Under Parametric Re both the trigger for covered events and the subsequent size of loss payment were determined entirely by the 'parameters' of the event (here the location and intensity of an earthquake), and not by any consideration of indemnity-based insurance losses incurred as a result of any covered event. This gives rise to so-called 'basis risk' – where the recovery from the bond does not necessarily match the recovery that would have been obtained under a comparable reinsurance policy. Basis risk is two-sided – the recovery under the bond may turn out larger or smaller than under a comparable reinsurance policy.



Basis risk is generally viewed as a negative by insurance company issuers, because of the potential for under-recovery compared to indemnity protection, but there are several benefits of a parametric (as opposed to an indemnity) structure, particularly for investors:

1. **Transparency.** The occurrence of such an event (a major earthquake) is clearly visible and its impact independently verifiable by investors.
2. **Valuation.** There is no need for investors to be familiar with the terms and conditions (perils covered, insured values, deductibles, limits, etc.) of every policy covered within a reinsured portfolio in order to immediately calculate the cost of any event to the bond, and to be able to mark-to-market it. Under an indemnity structure, even for so-called 'short-tail' classes of insurance such as property damage, it can take months, if not years, to settle all the claims on the policies within the reinsured portfolio, leading to post-event uncertainty over the level of any principal impairment, and hence the market value, of the bond.
3. **Prompt settlement.** Payment by the SPV to the Sponsor can be made within days of the parameters of the covered event being certified by the appointed calculation agent. Although this is an immediate benefit to the Sponsor, it also ultimately

Other deals with parametric triggers

The Artemis Deal Directory lists a total of 869 cat bonds up to the end of June 2022. Of these, there are 95 bonds with parametric triggers (from Parametric Re in 1997 up to the end of June 2022), with a total of $14.40bn of risk capital issued; the largest having been issued by the International Bank for Reconstruction and Development (IBRD) with the $500m 3-year bond IBRD CAR (2018) covering Chilean earthquake for the Republic of Chile.

The first parametric bond to be triggered and incur loss of principal was Muteki Ltd (2008), sponsored by Munich Re on behalf of the ultimate cedent or '(re)insured' Zenkyoren (the largest mutual personal lines insurer in Japan). Muteki Ltd was a 3-year bond providing $300m Japanese earthquake cover, issued in May 2008. The parametric trigger was an index based on the location and peak ground acceleration of earthquakes as reported by a network of onshore seismographs.

The losses incurred by Zenkyoren from the Tōhoku earthquake on the 11 March 2011 were large enough to lead to a complete exhaustion of the capital in Muteki Ltd; investors in the bond lost all their principal (Muteki Ltd is believed to have been the only cat bond to be impacted by the Tōhoku earthquake). However, settlement of the bond did not turn out to be as easy as had been anticipated, because the network of seismographs was damaged by the tsunami – and it was the tsunami that caused most of the insured losses, rather than the offshore earthquake itself.

benefits the investors as well, because at the maturity of the bond, any remaining unimpaired principal can be quickly returned to investors. Under an indemnity structure, if at maturity of the bond there are still outstanding claims, it can lead to the SPV being unable to release principal until reasonable finality of claims being settled is achieved – leading to what is known as 'trapped collateral'.

Motivation: Tokio Marine chose a parametric trigger to eliminate some of the uncertainties associated with timing and amount of recoverables under either an indemnity or an index trigger, and to accept the inherent basis risk (positive or negative) of the parametric structure. A non-indemnity structure removes a number of uncertainties from the perspective of investors – such as moral hazard, data reliability, damage resulting from any particular event, and delay in settling (retail) policyholder losses.

Deal 4: SR Earthquake Fund (1997) & Swiss Re – the first industry loss index cat bond

[Structuring & placement: Credit Suisse First Boston]

This cat bond provided Swiss Re with up to $137m of coverage for industry losses resulting from a California Earthquake. Losses would be calculated using the Property Claims Services (PCS) index for the State of California, and was the first cat bond to use such an industry loss index. Any losses payable to Swiss Re would be calculated proportional to Swiss Re's share of earthquake business written in California, i.e. if Swiss Re wrote 5% of the California earthquake business, and there was an earthquake adjudged by PCS to generate industry losses of $10bn, then Swiss Re's recovery from the cat bond would be based on a loss figure of 5% of $10bn, or $500m, subject to any attachment points and limits of the four series of bonds comprising the overall issue.

The SR Earthquake Fund was the first of 81 cat bonds (up to the end of June 2022) for which Swiss Re has been the cedent, far more than any other company, plus Swiss Re has played roles in the structuring and placement of many other cat bonds over this period.

The next industry loss index cat bond was issued by the California Earthquake Authority (CEA) in 2001 (see Deal 7). Since then cat bonds with industry loss index triggers have become more frequent, and by the end of June 2022 they had been used in 184 deals, totalling $36.4bn of risk capital. As at June 2022, industry loss index triggers were the second most common trigger mechanism, comprising a total of $9.8bn of the then-outstanding risk capital, accounting for 25% of the then-total outstanding risk capital of $38.6bn; indemnity triggers were the most common, comprising a total of $22.85bn of outstanding risk capital, 59% of the overall total.

Deal 5: Concentric Re (1999) / Oriental Land – the first cat bond issued by a non-financial corporation

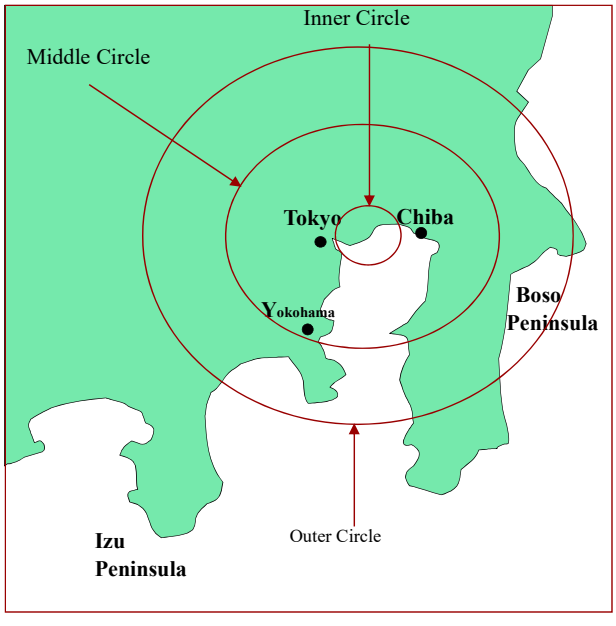
[Structuring & placement: Goldman Sachs; Risk modelling: EQECAT]

Concentric Re was the SPV created to provide $100m of cover on a parametric basis (similar to Parametric Re above), but was the first cat bond to be issued by a non-financial corporation (as opposed to an insurance company). Also the motivation was novel.

Structure: The 5-year Concentric Re bond (rated S&P 'BB+') provided $100m of parametric index linked 'insurance' based on the magnitude and location of any earthquake in the Tokyo region. The expected loss was 0.413% and the coupon 310bps.

The operation of the bond is illustrated in the following graphics:

Following any qualifying earthquake (of magnitude 6.5 of more in the inner circle, or 7.1 or more in the middle circle, or 7.6 or more in the outer circle), as certified by the Japanese Meteorological Agency (JMA), then the appropriate portion of the $100m limit would be paid as per the tabulation. For example, if there was an earthquake of size 7.4 on the JMA scale with an epicentre located in the middle circle, then from the table below there would be a pay-out of 62.5% of the bond, i.e. $62.5m.



JMA Magnitude	Inner Circle	Middle Circle	Outer Circle
6.5	25.0%	-	-
6.6	32.5%	-	-
6.7	40.0%	-	-
6.8	47.5%	-	-
6.9	55.0%	-	-
7.0	62.5%	-	-
7.1	70.0%	25.0%	-
7.2	77.5%	37.5%	-
7.3	85.0%	50.0%	-
7.4	92.5%	62.5%	-
7.5	100%	75.5%	-
7.6	100%	87.5%	25.0%
7.7	100%	100%	50.0%
7.8	100%	100%	75.0%
7.9 & higher	100%	100%	100%

Proportion of US$ 100 million limit payable to Oriental Land based on grid dependent upon location and magnitude of Earthquake

Depth of hypocentre of Earthquake must be less than or equal to 101 km.

Motivation: Oriental Land is not an insurance company, but a corporation that, amongst other activities, is the operator of Disneyland Tokyo. It had borrowed funds to build the theme park and wanted to protect its ability to service this debt. Any earthquake in the Tokyo region would likely result in a downturn in visitor numbers and revenues, even if the park facilities themselves were not directly damaged. In effect Concentric Re provided Oriental Land with stand-alone non-damage business interruption (NDBI) coverage – a form of coverage difficult to achieve in the traditional insurance market (where business interruption cover is only usually available as an extension to a physical damage policy, which usually warrants a stated amount of direct physical damage in order for the business interruption coverage to become operative).

Historical note: The centre point of the Inner Circle was the Cinderella Fountain in Disneyland Tokyo.

Outcome: During the 5-year tenure of Concentric Re there was neither a qualifying earthquake nor any other event that caused Disneyland Tokyo to suffer a fall in visitor numbers. With Oriental Land's debt then under control, it decided not to renew Concentric Re when it matured.

Postscript: There were no qualifying earthquakes during the 5-year risk period, so investors suffered no loss of principal or interest. Also over this period, Oriental Land paid down most of its debt – so did not feel the need to renew the Concentric Re bond when it matured in May 2004. However, following the 11 March 2011 Tōhoku earthquake and tsunami, Disneyland Tokyo was forced to close down on the 12 March. Although the earthquake was well away from the theme park and no direct damage was experienced, because of the loss of national generating power by Tokyo Electric Power (Tepco), the Japanese government required large users of electricity to cut their power usage by 25%. Tokyo Disneyland reopened on 15 April, following the installation of three power generators – although the cost of power from these generators was higher than that previously supplied by Tepco. The Tepco nuclear plant was well outside the outer circle of the Concentric Re footprint, and so no recovery would have been received if a subsequent Concentric Re 'n' cat bond had been in place – but this type of non-damage business interruption event was what lay behind the structure of the Oriental Land deal.

Other deals with parametric triggers

Personal lines insurance has also been offered on a parametric basis. Sinsai Partners Inc of Tokyo (since acquired by SBI Holdings in 2012) announced that from July 2008 they would sell parametric personal earthquake insurance policies, which would pay ¥50,000 whenever there was a tremblor above a certain intensity (6 upper or above on the JMA 10-stage seismic intensity scale), regardless of damage, for an annual premium of ¥4,500. An additional policy would pay ¥250,000 if a home were to be partially or completely destroyed, for a further premium of ¥2,900.

{Claims have been paid, more or less inadvertently, on a fixed sum basis under conventional indemnity insurance policies. For example, following the 87J windstorms of 15–16 October 1987 in the UK, the RSA insurance company announced that because of the large volumes of personal home insurance claims, policyholders would not have to submit builders' estimates in support of claims of less than £5,000. Guess how many claims were submitted at just under £5,000!}

Also there have been a number of cat bonds subsequently issued by companies, other than (re)insurers – these 25 deals are listed in Appendix 1A, and together account for a total $10.35bn of risk capital.

Deal 6: Gold Eagle Capital (1999) / American Re – the first modelled loss cat bond

[Structuring & placement agents: American Re Securities Corp., Merrill Lynch, Salomon Smith Barney; Risk modelling: RMS]

Structure: Gold Eagle Capital (1999) was the first ILS security to have a modelled loss trigger. It provided American Re with $182.6m cover over 16 months for Eastern or Gulf Coast hurricanes and Midwest or California earthquakes, in three tranches - $50m Class A rated Moody's 'Baa3', $126.6m Class B rated 'Ba2' and $6m Class C unrated.

Any payments would be determined with reference to the RMS Cat Index. Any payments made by the bonds would be triggered by the size of modelled insurance industry losses (using the RMS Cat Index) from the covered event, not the actual losses incurred by American Re.

Outcome: When Gold Eagle Capital matured, American Re issued a further Gold Eagle Capital II (2001) one-year bond, providing $120m of cover for Eastern or Gulf Coast hurricanes and Midwest earthquakes, again on a modelled loss basis.

Other deals with modelled loss triggers

The Artemis Deal Directory lists 37 bonds with modelled loss triggers (up to the end of June 2022), with a total of $4.221bn of risk capital issued; the largest having been issued by PXRE with the $300m 5-year bond Atlantic & Western Re (2005).

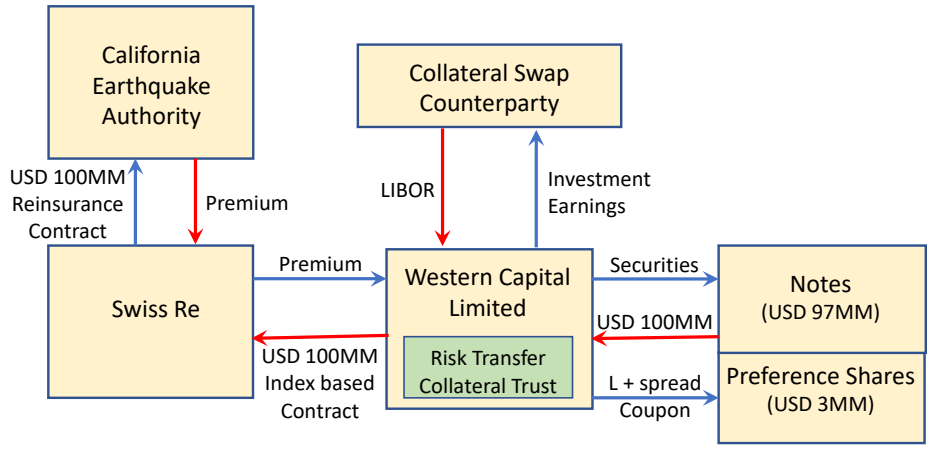
Atlantic & Western Re (2005) was one of the first cat bonds to default, when PXRE failed to make its Q1 2007 premium payment to Atlantic & Western Re, so that Atlantic & Western Re could not make its quarterly coupon payment to the bond holders. On 13 Feb 2007 S&P downgraded Atlantic & Western Re's Class A notes from 'BB' to 'D', the Class B notes from 'B' to 'D' based upon "its interpretation of (PXRE's) management intentions as set forth in the 8-K filed Feb 9. It was disclosed that PXRE Group Ltd's board of directors may pursue strategic alternatives that do not involve significant catastrophe exposures … To effect an early redemption, PXRE would be expected to not make a required premium payment, which would result in a default on the notes." In other words, withholding the quarterly premium payment to Atlantic & Western Re was the easiest, and perhaps only way (without an early redemption clause) for PXRE to force early redemption of the bonds several years before maturity, because PXRE did not anticipate writing business any longer that would require the coverage provided by Atlantic & Western Re with its extremely high attachment point. In fact, PXRE had gone into run-off in February 2006 (following losses from the 2005 Gulf of Mexico hurricanes) and within a month of the Atlantic & Western Re downgrade, PXRE was acquired by the Argonaut Group – only to be then sold on to run-off consolidator Tawa PLC in November 2007.

Deal 7: Western Capital (2001) / California Earthquake Authority – the first cat bond issued by a public entity or government agency

[Structuring & placement: Swiss Re Capital Markets, Goldman Sachs; Risk modelling: EQECAT]

As noted above (Deal 0) the California Earthquake Authority (CEA) did not take up the 1996 proposal to issue Earthquake Risk Bonds (ERB), but the CEA did issue its first cat bond, Western Capital, in 2001.

Structure: Western Capital was the issuer of a $100m cat bond on behalf of the CEA. The bond provided cover against one or more major Californian earthquakes over just under a 2-year period. Payment under the bond was linked to an industry loss index, as provided by Property Claim Services (PCS), and was rated 'BB+' by S&P and 'Ba2' by Moody's.



The Western Capital Transaction

Source: Issues Paper on Non-Life Securitisation, International Association of Insurance Supervisors (IAIS), October 2003

Outcome: CEA followed up on Western Capital (2001) by issuing three Embarcadero Re bonds (2011 to 2012), seven Ursa Re bonds (2014 to 2019), one Sutter Re bond (2020) and 3 Ursa Re II bonds (2022 to 2022) – the largest of which was Ursa Re II (2017-1) at $925m. These 15 cat bonds comprise a total $5.760bn of risk capital, with an average of $384m per bond.

Ursa Re II (2017-1) at $925m was the sixth largest cat bond issuance known to date.

The top five are:

1. Everglades Re (2014) / Citizens Property Insurance $1.5bn
2. Merna Re (2007) / State Farm $1.1bn
3. Successor (2006) / Swiss Re $950m
4. Kilimanjaro Re II (2007) / Everest Re $950m
5. Everglades Re II (2021) / Citizens Property Insurance $950m

None of the CEA bonds are publicly known to have incurred any losses (at time of writing). Since the 6.7 M_w Northridge earthquake in 1994 (with insured losses of $26.86bn in 2019 dollars[14], the next most costly Californian earthquake in terms of insured losses has been the 6.0 M_w South Napa earthquake in 2014 (with insured losses of $162m in 2019 dollars).

Western Capital (2001) was also only the second industry loss index bond to be issued – the first was the $137m SR Earthquake Fund, issued by Swiss Re in 1997, also covering California earthquake (see Deal 4 above). The Artemis Deal Directory lists 185 bonds with industry loss triggers (up to the end of June 2022), with a total of $36.486bn of risk capital issued; the largest having been issued by Everest Re with the $950m 4-year bond Kilimanjaro II (2017-1), issued at the same time as the 3-year $300m bond Kilimanjaro (2017-2), both covering US, Canada, Puerto Rico and D.C. named storm and earthquake.

There have been a number of cat bonds subsequently issued by various government or other public entities; there are 16 such deals listed in Appendix 1B, giving a total of $8.9bn of risk capital issued.

14 Source: Insurance Information Institute

Note on trigger types

The four main trigger types that have been used in cat bonds are indemnity, modelled loss, industry loss index and parametric, and sometimes a hybrid of the basic types. They each have their advantages and disadvantages to Sponsors and Investors.

Overview of Triggers: Advantages and Disadvantages for Sponsors

TRIGGER	ADVANTAGES	DISADVANTAGES
Indemnity	• No or limited basis risk – reflects sponsor's loss	• Substantial disclosure required by sponsor • More expensive • More detailed risk analysis by modeling firm • Longer ratings process • Adjustment to provide for sponsor's portfolio growth • Long loss recovery period • Less attractive to investors • Possible moral hazard
Parametric Index	• Simpler process to execute • Possible cost advantages due to greater investor interest • No need for sponsor to disclose confidential information • Rapid payout	• Basis risk • Possible accounting issues (mark-to-market)
Industry-Loss Index	• Simpler process to execute • Possible cost advantages due to greater investor interest • No need for sponsor to disclose confidential information	• Basis risk • Long payout period • Possible adjustment needed to provide for industry's portfolio growth • Possible accounting issues (mark-to-market)
Modeled-Loss Index	• Simpler process to execute • Possible cost advantages due to greater investor interest • No need for sponsor to disclose confidential information • Short payout period	• Basis risk (potentially less than other indices) • Possible adjustment needed to provide for industry's portfolio growth • Investors may be uncomfortable with a "black box" approach • Possible accounting issues (mark-to-market)
"Hybrid"	• Very flexible – different sub-trigger types can be used to address different perils within a single transaction • Should further reduce basis risk relative to other non-indemnity trigger types	• Basis risk, though in theory reduced, still remains • If trigger mechanics are too complex investors may be uncomfortable with the approach • May require additional time to construct, increasing total time required to complete transaction and potentially issuance expense

Overview of Triggers: Advantages and Disadvantages for Investors

TRIGGER	ADVANTAGES	DISADVANTAGES
Indemnity	• No advantage compared to industry loss or parametric triggers • Moral hazard issue	• Long delay time to calculate loss claims, leading to inefficient secondary trading
Parametric Index	• No moral hazard issue • Possibly more liquid • Quick verification of trigger	• No major disadvantages
Industry-Loss Index	• No moral hazard issue • Possibly more liquid • May provide more rapid verification of trigger than indemnity	• Long delay time needed to verify final PCS number, leading to inefficient secondary trading
Modeled-Loss Index	• No moral hazard issue • Possibly more liquid • May provide more rapid verification of trigger than indemnity	• Reliance on "black box" approach
"Hybrid"	• No moral hazard issue • Depending on hybrid components, possibly more rapid loss verification than industry-loss index triggers	• Complex triggers may make transaction difficult to understand • Certain hybrid triggers may involve an indemnity sub-trigger

Source: The Catastrophe Bond Market at Year-End 2016, MMC Securities

Deal 8: Bay Haven (2006) / Catlin – a CDO cat bond structure

[Structuring: Guy Carpenter; Placement: ABN Amro; Risk modelling: RMS]

Structure: Catlin's first cat bond issue utilised a Collateralised Debt Obligation (CDO) structure. The $200.25m 3-year floating rate notes were issued in two tranches:

- The $66.75m Mezzanine tranche (rated BBB-) paid a coupon of Libor+425bps
- The $133.50m Senior tranche (rated AA) paid a coupon of Libor+150bps

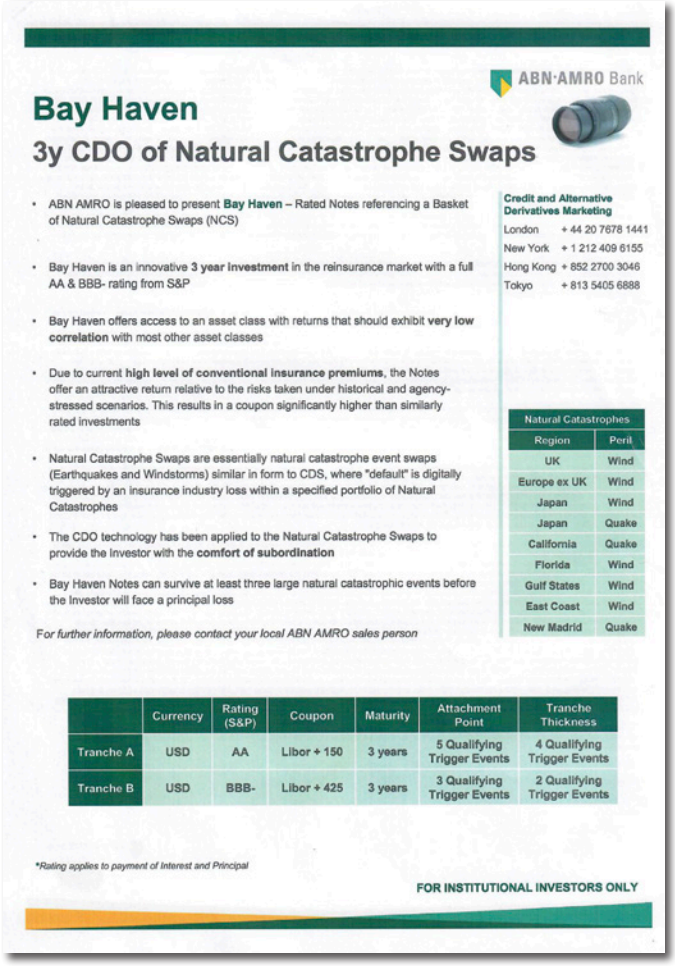
The CDO structure comprised a portfolio of 9 specified perils, 5 US indemnity and 4 non-US parametric:

Indemnity	Parametric
California earthquake	UK wind
Florida wind	Europe (ex UK) wind
Gulf States wind	Japan wind
East Coast wind	Japan earthquake
New Madrid earthquake	

with any indemnity peril losses being assessed by Property Claims Services (PCS) and any parametric losses being assessed by the cat modelling company RMS.

Cover up to $33.375m was provided for each loss event, with:

- The 1st, 2nd and 3rd of any loss events to occur to be retained by Catlin
- Any 4th and 5th loss events to be paid by Mezzanine tranche bondholders
- Any 6th, 7th, 8th and 9th loss events to be paid by Senior tranche bondholders



Outcome: Catlin sponsored a number of further cat bonds, Newton Re (2007) for $225m with an industry loss index trigger, Newton Re (2008) for $150m with an indemnity trigger (one of the bonds suffered a partial loss following the Lehman Bros collapse – see Deal 8 for more details), Galileo Re (2013) for $300m, Galileo Re (2015) for $300m, and following the merger of XL and Catlin, XL Insurance sponsored Galileo Re (2016) for $300m (all the Galileo bonds had industry loss index triggers).

XL had not previously sponsored a cat bond, but had engaged in a $200m US and Caribbean hurricane and earthquake swap during its incarnation in 1998 as XL Mid-Ocean Re.

Following the final completion of the Catlin and XL merger, XL Bermuda started a new series, Galileo (2016) for $300m, Galilei (2016) for $750m, Galilei Re (2017) for $525m, Galileo Re (2017) for $150m, and Galileo Re (2019) for $475m.

Deal 9: Gemini Re (1998) / Allianz – the first pure European peril cat bond

[Structuring & placement: Allianz, Goldman Sachs; Risk modelling: RMS]

Gemini Re has been selected as a harbinger of the diversification of the geographic spread of perils, conducive to building a portfolio for ILS investors. The vast majority, many hundreds, of cat bonds over the 25 years have covered US perils, primarily US earthquake followed by US hurricanes and named storms. The country with the second largest number of cat bonds covering its natural perils is Japan, with Japan earthquake (30), Japan typhoon (10) and Japan multi-peril (6).

Admittedly George Town Re (1996) – Deal 1 above – provided worldwide all perils, and Pacific Re (1998) covered Japan typhoon, but Gemini Re was the first cat bond to cover a non-US, non-Japan, single peril, and so has been chosen as a representative deal. Gemini Re provided $150m of cover for German windstorm and hail losses, over a 3-year period, triggered by a predetermined event.

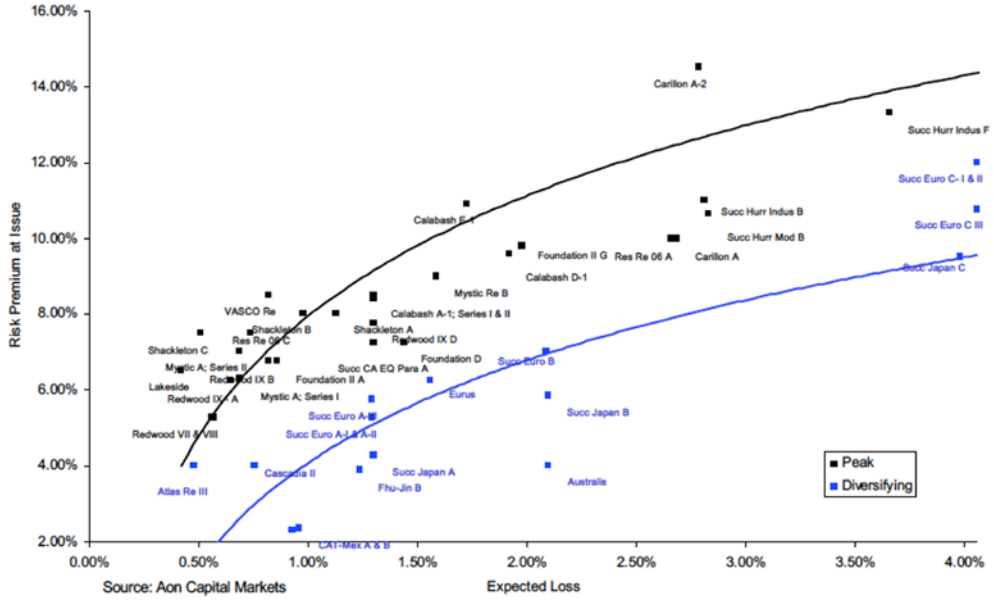
Apart from cat bonds covering perils in the Americas, Caribbean and Japan, over the last 25 years there have been the following 46 cat bonds issued:

European windstorm (25)	Oak Capital (2003, 2004 & 2004), Pylon (2003 & 2011), Aiolos (2005), Eurus (2006, 2009 & 2012), Successor Euro Wind (2006), Blue Fin (2007), Green Valley (2007 & 2010), Queen Street (2008 & 2010), Calypso Capital (2010, 2011 & 2013), Green Fields Capital (2010 & 2013), Windmill Re (2013, 2017 & 2020), Lion Re (2014), Hexagon Re DAC (2017)
European earthquake (3)	Azzurro Re (2015, 2020 & 2022)
European multi-peril (8)	Gemini Re (1998), Mediterranean Re (2000), Atmos Re DAC (2019)[15], Hexagon Re DAC (2019 & 2021), Lion Re (2021), Orange Capital Re DAC (2021), Artex SAC (2022)
Mediterranean earthquake (1)	MedQuake (2007)
Turkish earthquake (3)	Bosphorus Re (2013 & 2015), ILN SAC Ltd (2020)
China earthquake (1)	Panda Re (2015)
China typhoon (1)	Greater Bay Re (2021)
Taiwan earthquake (1)	Formosa Re (2003)
Australia & New Zealand (3)	Australis (2006 & 2007), Orchard ILS (2019)

There have also been a number of cat bonds that cover a combination of European windstorm with US earthquake & hurricane and/or Japan earthquake, such as the Atlas series of bonds issued by SCOR. However, as at June 2022, cat bonds covering solely European perils only represented a little over 1.5% of all the cat bond and ILS risk capital outstanding.

The value of geographical diversification in an ILS investor's portfolio can be illustrated by the following chart of cat bond pricing, where the line of Risk premium to Expected loss multiples is significantly lower for Diversifying than Peak cat bonds. For instance, the first Australian cat bond, Australis (2006), had a Risk premium to Expected loss multiple of around 2, where the general multiple for other Diversifying issues was just over 3 and for Peak issues was around 5.5.

15 Atmos Re covers atmospheric perils which includes all kinds of severe weather-related risks, such as wind storms, hail storms, thunder storms, tornadoes, snow storms, blizzards, and flooding (pluvial, fluvial and coastal / storm surge). It also includes 'snow pressure', the risk of build-up and weight of snow or ice causing roof collapse and other structural damage



16 'The Loss File – Natural Catastrophe ILS issues 2001-2020, Morton N Lane, wwwlanefinancialllc.com

17 Figures taken from www.artemis.bm/cat-bond-losses/

Tailpiece on losses suffered by property catastrophe bonds

There have been relatively few property cat bonds that have defaulted and suffered partial or full loss of principal. The first cat bond to suffer a full, and the largest to date, loss of principal was Muteki (2008), with a $300m default resulting from Zenkyoren claims from the Tōhoku earthquake in 2011. Other bonds believed to have suffered a full loss of principal are:

- Mariah Re (2010-1) and Mariah Re (2010-2), issued by American Family Mutual Insurance Co. – both with a $100m default due to US severe thunderstorms in 2011
- Residential Re (2014), issued by USAA, with an $80m default, and Residential Re (2015), with a $50m default, both due to Hurricanes Harvey and Irma, and California wildfires and winter storms in 2017/18
- Citrus Re (2015, 2016 & 2017), issued by Heritage Property and Casualty Insurance Co., with a combined default of $263m across these bonds due to Hurricane Irma in 2017
- Manatee Re (2016), issued by Safepoint Insurance Co, with a $20m default due to Hurricane Irma in 2017
- IBRD CAR 113 Class A, Mexico (2017), with a $150m default due to Mexican earthquake in 2017
- Residential Re (2018), issued by USAA, with a $100m default, due to Hurricanes Florence and Michael, California wildfires, convective weather & tornadoes in 2018
- Cal Phoenix (2018), issued by PG&E Corporation, with a $200m default due to the Camp Wildfire in California in 2018
- Atmos Re DAC (2019), issued by UnipolSai Assicurazioni SpA, with a $45m default due to severe weather and flooding

There are several other property cat bonds that have made partial payments of principal, with further amounts still outstanding, and a further group of cat bonds that have not yet made any payments of principal, but have amounts outstanding. Cat bonds are traded in the secondary market, and calculating the final losses on all these bonds implied by market prices, Morton Lane has estimated that the total paid and outstanding loss of principal on property cat bonds issued between 2001 and 2020 was around $3.5bn[16].

The main peril to have caused losses across several cat bonds has been US hurricane – Hurricanes Harvey, Irma and Maria in 2017, and Hurricanes Florence and Michael in 2018 – plus Californian wildfires in 2018, severe thunderstorms and winter storms. Other major events to cause partial losses to just a single bond have included the Tōhoku earthquake (2011), Hurricane Sandy (2012), and earthquakes in Mexico and Peru. The most unusual reason for cat bonds to have suffered loss of principal was total return swap counterparty default (due to the collapse of Lehman Bros in 2008), which impacted four bonds: Allstate's 2008 bond Willow Re, Catlin's Newton Re (2008-1), Aspen Insurance's 2007 bond Ajax Re and Munich Re's 2006 bond Carillon Ltd. The value of the collateral assets under the total return swaps was not enough to make full payment, giving rise to a combined loss amount across the four bonds of $117m[17].

Cat bonds covering non-property, non-life risks

B

Deal 10: Kelvin (1999) / Koch Energy – first weather-based cat bond

[Structuring & placement: Goldman Sachs; Risk modelling: RMS]

Structure: Kelvin Re was a Cayman Islands special purpose company formed in 1999 to enter into a weather portfolio swap with Koch Energy Trading.

Kelvin Re issued $45m of securities to investors to fund a 3-year transaction covering the risk of certain levels of annual losses across a portfolio of 28 weather derivative contracts based on the temperatures at 19 weather stations throughout the US.

Losses: Some of the weather stations did record temperatures that activated the triggers, but there is no publicly available data on the levels of payouts incurred, although it is believed that the excess cold temperatures experience in the winter of 2000-2001 in the US Northeast caused losses of around $5.1m.

Outcome: Weather risk (such as extreme temperatures or drought) is the subject of many other ILS transactions (such as derivatives and swaps), but only two further cat bonds are known to have been issued to date covering temperature risk. Market Re (2016-5) and Market Re (2017-2), two of the Market Re series of bonds, were issued by Allianz Risk Transfer to provide $30.75m and $14.5m respectively of 1-year of parametric-based collateralised retrocession coverage for warm-weather winters across Europe.

Deal 11: Horizon (2002) / SCOR – the first credit reinsurance cat bond

[Placing: JP Morgan]

Structure: SCOR issued the €130m Horizon (2002) 5-year bond to provide some protection on its credit reinsurance exposures. Any loss settlement was determined on an index basis linked to weighted credit risk populations rated between Moody's A1 and Baa3.

Postscript: A later credit reinsurance securitisation by Swiss Re, Crystal Credit (2006), was a 3–year bond providing €252m of indemnity cover for aggregate losses on the claims and reserves Swiss Re had on its underwriting years 2006, 2007 and 2008. The notes were in three classes:

- Class A €108m (rated Baa2/BBB-)
- Class B €81m (rated Ba2/BB)
- Class C €63m (rated B2/B)

The average coupon was Euribor+3.93%. Under Crystal Credit, Swiss Re would retain the first €666m of losses. Ceded losses ran more or less as expected for a while, but in the 4th quarter 2008 the global credit crisis started biting, and ceded losses started accelerating. The bonds were downgraded in August 2009, when it became clear that Swiss Re had incurred sufficient credit reinsurance losses likely to trigger the bonds, but would probably not be able to deliver final proof of loss until April 2012. In August 2011 Swiss Re redeemed the Class A notes in full. In January 2012 aggregate losses had finally reached €771m, so the Class C investors suffered a complete loss of €63m, and Class B investors suffered a partial loss of €42m (i.e. retention of €666m + €63m Class C + €42m Class B = €771m).

Deal 12: Avalon Re (2005) / Oil Casualty Insurance Limited (OCIL) – the first casualty cat bond transaction

[Structuring & placement: Goldman Sachs; Calculation agent: Milliman]

Structure: Avalon Re was a 3-year cat bond sponsored by Oil Casualty Insurance Limited (OCIL) – a Bermuda-based mutual insurance company providing (re)insurance, primarily excess liability coverage, to a broad range of industries with a focus on the Energy industry.

Avalon Re provided $405m of umbrella general liability coverage in 3 layers (each of $150m with a 10% retention). It was a CDO-type structure (like Bay Haven in Deal 8 above), with the 1st and 2nd events retained by OCIL (but partially protected by conventional reinsurance), and Avalon Re providing 3rd, 4th and 5th event cover, as follows:

Notes	Layer	Coupon	Expected loss
Series C	90% of $150m xs $300m	Libor+775bps	221bps
Series B	90% of $150m xs $450m	Libor+360bps	40bps
Series A	90% of $150m xs $600m	Libor+212.5bps	6bps

Losses: During its risk period, 1 July 2005 to 31 May 2008, OCIL experienced a series of qualifying losses:

1st event: Hurricane Katrina (29 August 2005) caused an oil spill from a Murphy Oil Corp (an OCIL insured) crude oil tank, leading to a number of third-party claims, on which OCIL paid a loss of $147m.

2nd event: The explosion at the Hertfordshire Oil Storage Depot (known as Buncefield) in the UK (on 11 December 2005), which was jointly owned by Total and Texaco (both OCIL insureds), led to OCIL incurring a full loss of $150m. {6 months into the 3-year term and already Avalon Re was heavily exposed to the next loss event.}

3rd event: A Consolidated Edison steam pipe exploded in New York (18 July 2007), initially reserved at $65m - although the final settlement after considerable confusion and some litigation turned out to be $17.1m. This initial loss reserve meant that Series C notes would suffer some loss of principal, and with nearly a year of the risk period still to run, the Series B notes now became more exposed.

4th event: there were rumours of further qualifying loss(es) – an oil refinery spill at Lake Charles and lead paint claims. However, in the end, no further claims were notified.

The Series A notes were repaid in full on the scheduled maturity date of 6 June 2008, but because of uncertainty over the final settlement figures of the potential loss events, the maturity dates on the Series B and C notes were extended a number of times. Secondary trading started taking place in the Series C notes at around 45% of face value, and in the Series B notes at around 70% to 75% of face value. To help resolve the uncertainty, in September 2009 OCIL offered to buy back up to $50m of


Avalon Re, Ltd. Issues $405MM of Variable Rate Notes to Securitize 3 Year Reinsurance Deal for OCIL

OCIL has put in effect a major multi-faceted casualty reinsurance placement, including $405,000,000 of reinsurance from Avalon Re, which was financed through the issuance of variable rate notes. In addition to the securitized reinsurance transaction, OCIL purchased a further $287,500,000 of conventional commercial reinsurance from London, Bermuda and US markets while retaining $207,500,000 of risk throughout its $900,000,000 reinsurance tower.

The net effect of this structure positions OCIL with high quality stable three-year reinsurance protection from Avalon Re that uniquely complements the company's annual commercial reinsurance placement.

It is believed that the Avalon Re placement is the first time significant casualty risks have been securitized in the same way that property risks have been placed in the capital markets using CAT bonds.

Goldman Sachs & Co. acted as lead manager on the securities offering, which was made pursuant to Rule 144A under the Securities Act of 1933. Paterson Martin provided modeling and actuarial design services, and LeBoeuf, Lamb, Greene & MacRae LLP acted as special reinsurance counsel to OCIL. Carvill Re, a division of R.K. Carvill & Co. Ltd., acted as OCIL's reinsurance adviser for the securitization and as reinsurance intermediary for the commercial reinsurance placement.

the Series B notes at 85 cents on the dollar, but only $7m were offered for repurchase. Ultimately the Series B notes were repaid in full, and the Series C notes suffered a $12.96m loss of principal (i.e. total losses on the three events incurred by OCIL = £147m + $150m + $17.1m = $314.1m, and so the loss to Series C notes was 90% of $14.1m).

This somewhat messy experience illustrated that the use of a cat bond transaction to cover casualty risks was fraught with inherent uncertainty, due to the long-tail nature of the risk, with potential long delays in the discovery and/or settlement of any qualifying losses. The intention behind the structure of Avalon Re was to provide protection for third-party liability from 'extreme' events – so that the occurrence and cost of any such events would be fairly readily apparent – unfortunately as events turned out, this did not prove to be the case.

Deal 13: FCC SPARC / Nexgen Re (2005) / Axa – the first motor portfolio cat bond transaction

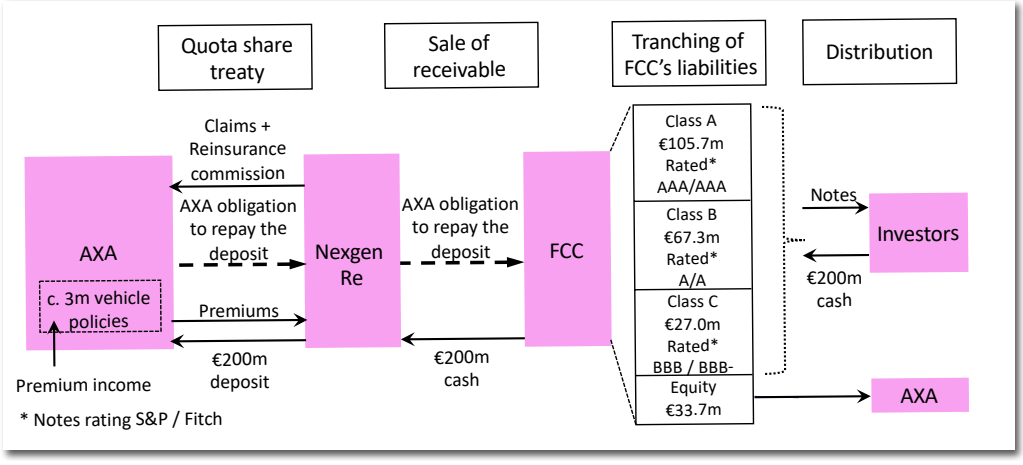
[Structuring: IXIS; Risk modelling: Fitch Ratings]

Structure: Axa transferred through Nexgen Re (2005) a 4-year quota share treaty (over four consecutive annual periods) covering up to 85% of Axa France IARD's motor insurance portfolio sold through its tied agents' network in France. This portfolio comprised 2.9m individual motor policies, with a premium total of around €1.1bn. However, excluded from the transferred portfolio were:

- Motor fleet policies
- Overseas departments
- Any loss event over €4m
- Natural catastrophe cover (windstorm, hail, snow)

NexGen Re then used a Fond Commun de Créances (FCC – a French mutual debt fund structure) to issue €200m of notes in three classes, as follows:

- Class A €105.7m, paying losses between loss ratio trigger+9.8% and +20.8%, and paying 3-month Euribor+15bps (rated S&P/Fitch 'AAA')
- Class B €67.3m, paying losses between loss ratio trigger+2.8% and +9.8%, and paying 3-month Euribor+37bps (rated 'A')
- Class C €27.0m, paying losses between loss ratio trigger and +2.8%, and paying 3-month Euribor+59bps (rated 'BBB')



The AXA Structure

Source: Towers Perrin Tillinghast, Axa's Motor Insurance Book Securitisation, Update January 2006

The loss ratio trigger on the transferred motor portfolio was not disclosed to investors (because it was deemed commercially sensitive), but only advised to the credit rating agency to enable it to rate each tranche and then to certify any qualifying losses each year. The loss ratio trigger was also reset each subsequent year to preserve the probability of losses and the credit rating – because Axa was able to affect one component of the loss ratio, namely premium levels.

Outcome: Axa followed this with a similar transaction, FCC SPARC 2007, covering a quota share of Axa France's pan-European motor insurance portfolio, including policies sold in Spain, Germany, Italy and Belgium – a total of 6m contracts and a premium total of €2.591bn. The €472.6m issue again covered four consecutive annual periods, and was in four tranches:

- Class A €91.5m, paying losses above loss ratio trigger+20.0%, (rated S&P/Fitch 'AAA')
- Class B €220.0m, paying losses between loss ratio trigger+9.9% and +20.0%, (rated 'A+')
- Class C €100.1m, paying losses between loss ratio trigger+5.3% and +9.9%, (rated 'BBB')
- Class D €61.0m, paying losses between loss ratio trigger+3.5% and +5.3%, (rated 'BB-')

Motivation: Neither of the transferred portfolios were catastrophic in nature in any respect. Axa's main motivation was believed to be 'proof of concept', to see if a non-catastrophe portfolio of personal lines insurances could be 'securitised' and transferred off the balance sheet (in much the same ways as banks at the time were securitising mortgages, credit card receivables, etc.) in case the capital requirements of the forthcoming Solvency II regime proved onerous for high premium volume, but low risk, lines of insurance business. As Henri de Castries, the then-Chairman of Axa, said "[Transactions such as FCC SPARC] *will allow insurance companies to benefit from and enjoy the same ability to manage their equity as banks"*, allowing insurance companies to focus on origination of policies and not warehousing the risks, and so not having to hold, potentially excessive, required regulatory capital.

Another motor deal

Generali used Horse Capital I DAC (2006) to provide €225m of annual aggregate cover for its motor third-party liability loss ratios on its European subsidiaries' business.

Deal 14: Golden Goal Finance (2003) / FIFA – the first cat bond to cover terrorism

[Structuring & placement: Credit Suisse First Boston, Co-placement: Swiss Re Capital Markets; Risk modelling: RMS]

This cat bond was not purely a terrorism policy, it had an event cancellation trigger, but terrorism was regarded as the most likely peril to cause cancellation of the 2006 Football World Cup.

Structure: The Fédération Internationale de Football Association (FIFA) organises the Football World Cup, held every four years. Since 1998 FIFA had purchased $900m of event cancellation cover from the conventional insurance market. However, following the terrorist attack on the World Trade Centre on 11 September 2001, Axa gave notice

that it would withdraw its CHF1.4bn event cancellation policy for the 2002 World Cup, which was to be held in South Korea and Japan. FIFA had paid all the staged premium payments due thus far (CHF16.4m out of a total of CHF27.4m)[18]. FIFA obtained a replacement non-cancellable insurance policy with National Indemnity (a subsidiary of Berkshire Hathaway), but FIFA judged it to be extremely expensive. So as to remove counterparty credit risk for the next World Cup, to be played Germany in 2006, FIFA sponsored a $262m cat bond Golden Goal (2003), which was structured in four tranches to diversify the investor base:

- Class A1, $210m paying 3-month Libor+150bps
- Class A2, Sfr30m paying 2.851% fixed rate
- Class A3, €16m paying 3-month Libor+150bps
- Class A4, $10m paying 3.895% fixed rate

All the bonds were rated A3 by Moody's.

The bond would have paid FIFA if the 'Final match' of the 64-match 2006 World Cup competition (due to be played in Berlin on 9 July 2006) was cancelled, and had then not been played on or before 31 August 2007 in either Germany or another country, subject to:

- Exclusions: World War; boycott by at least 4 teams; radioactive contamination in Germany (not terrorist related); unfit stadia; FIFA insolvency
- Warranties: German Government responsible for security & safety and fitness of stadia

Although it was judged very unlikely that a Football World Cup would ever be cancelled, FIFA's gross revenues from the 4-yearly World Cup represents in excess of 90% of FIFA's gross revenues (many of the other events that FIFA organises operate at a loss and are subsidised). If the 2006 FIFA World Cup™ had been cancelled, it was expected that FIFA would have had to repay at least CHF1.2bn to television companies that had pre-paid for the rights to broadcast the event.

Extract from FIFA Financial report 2006, under Cancellation insurance:

> *FIFA covered part of the risks relating to the cancellation, curtailment and abandonment of the 2006 World Cup™ by means of a capital market transaction. Since it is very difficult and expensive to find adequate insurance cover for future FIFA World Cup™ competitions, FIFA plans to increase its equity to cover this exposure.*

However, FIFA reverted to the conventional market for subsequent World Cups, and was reported to have $900m in event postponement and/or relocation insurance for the 2018 World Cup in Russia. Coverage is believed to include natural catastrophe, accidents, turmoil, war, acts of terrorism, non-participation of teams and epidemic diseases (but not cancellation, because FIFA believes that if an event is delayed for any reason, then it is extremely unlikely that it will be cancelled altogether).

There have been two subsequent placements of 'pure' terrorism risk directly into the capital markets, both issued by the UK terrorism reinsurer, Pool Re. These two issues to date are the $97m Baltic PCC (2019) and $131m Baltic PCC (2022).

18 FIFA Statement on Insurance Cover for the 2002 FIFA World Cup Korea/JapanTM, FIFA Media Release, 12 Oct 2001

Deal 15: Golden State Re (2011) & California State Compensation Insurance Fund – the first workers' compensation cat bond

[Structuring & placement: Willis Capital Markets & Advisory; Risk modelling: RMS]

Structure: The SPV Golden State Re (2011) was formed in Bermuda to enable the California State Compensation Insurance Fund (SCIF) to issue a 3-year $200m bond (rated S&P 'BB+') to provide cover on a per-occurrence basis for workers' compensation losses due to fatalities or injuries to employees from earthquake damage to covered workplaces. Coverage is for the whole of the 50 US States and the District of Columbia, but almost all (around 99.99%) of the SCIF's insurance portfolio is in California.

Any loss payments would be determined on a parametric modelled loss trigger, using a notional portfolio of risks, adjusted not just by the earthquake severity factors (ground motion) and types of building covered, but also day of the week and time of day – to factor in whether people would be mostly at work or at home (because places of work will be more heavily populated during working hours than not – 2pm on a working day is the peak exposure). The initial annual expected loss was 0.36% and the coupon 3.77% (a multiple of 10.47).

No known historical California earthquake would have caused a loss to the bond, but three historical events would have exceeded the attachment point if they had occurred at different times on a working day:

- 1857 Fort Tejon – a loss if the event had occurred at 2pm on a working day (actually occurred at 8:20am on Friday 9 January)
- 1906 San Francisco – a loss if the event had occurred between 8am and 4pm on a working day (actually occurred at 5:12am on Wednesday 18 April)
- 1994 Northridge – a loss if the event had occurred between 8am and 4pm on a working day (actually occurred at 4:30am on Sunday 17 July)

Outcome: When this Golden State Re (2011) bond matured, the California SCIF issued a follow-up bond on a similar basis, Golden State Re II (2014), but with a longer 4-year tenure and an increased limit of $250m (rated S&P 'BB+'), and higher attachment point. Therefore, the initial annual expected loss was lower at 0.25% with a corresponding lower coupon at 2.20% (a multiple of 8.80).

And again, when the Golden State Re II (2014) bond matured, the California SCIF issued a follow-up bond on a similar basis, Golden State Re II (2018), again with a 4-year tenure but with a lower limit of $210m (rated S&P 'BB+'), and again with a higher attachment point. Therefore, the initial annual expected loss was lower at 0.14% but with an unchanged coupon at 2.20% (a multiple of 15.71), reflecting more other catastrophic losses incurred around the world at that time, rather than any specific Californian earthquake events.

"A 3-year bond ... to provide cover on a per-occurrence basis to workers' compensation losses due to fatalities or injuries from earthquake damage to covered buildings"

Deal 16: Bellemeade Re (2015) / United Guaranty (AIG) – the first mortgage insurance transaction

[Structuring & bookrunner: Credit Suisse; Co-managers: AIG, BNP Paribas]

Structure: Bellemeade Re is Special Purpose Insurance (SPI) vehicle formed in Bermuda to provide reinsurance protection on an aggregate indemnity basis to United Guaranty (an AIG subsidiary) on losses from mortgage insurance policies (i.e. policies that pay out when a borrower defaults on their mortgage).

Bellemeade Re (2105-1) issued a total of $298.89m in notes split into three tranches, all with 10-year terms:

- Class B-1 $14.429m, paying 1-month Libor+630bps
- Class M-1 $140.168m, paying 1-month Libor+250bps
- Class M-2 $144.291m, paying 1-month Libor+430bps

Outcome: Bellemeade Re (2015-1) became the first in a series of mortgage insurance cat bonds issued on behalf of United Guaranty, being followed by the $298.6m 10-year bonds of Bellemeade Re II (2016-1). United Guaranty was then acquired by Arch Capital, who continued the mortgage insurance bonds with the $368m 10-year bond of Bellemeade Re (2017-1), plus three more bonds in 2018, and four more bonds in each of 2019 and 2020, three in 2021 and one in 2022. The largest of these 18 issues is the $701m of Bellemeade Re (2019-3), and these 18 Bellemeade Re bonds now total $8.2bn, with an average size of $458m.

Other issuers of mortgage insurance cat bonds have been National Mortgage Insurance Corporation (with five since 2017), Essent Guaranty (with seven since 2018), Genworth Mortgage Insurance (with five since 2019), MGIC Investment (with six since 2018), National Mortgage Insurance Corporation (with seven since 2018), and Radian Guaranty (with six since 2018). Overall (up to June 2022) there have been 49 mortgage insurance cat bonds that have raised a total of $20.461bn, with an average size of $417.6m.

Deal 17: Operational Re (2016) / Credit Suisse – the first operational risk cat bond transaction

[Structuring & placement: Credit Suisse; Risk modelling: Milliman]

Structure: Zurich International wrote a CHF700m (~$687m) operational risk insurance policy for Credit Suisse, covering a large portfolio of risks including some cyber risk (such as IT system failure that causes business interruption), fraudulent behaviour (both of external parties and employees of the investment bank), fiduciary losses, losses due to improper business practices or unauthorised activity, accounting errors, documentation errors, regulatory compliance issues, HR issues, discrimination in the workplace or even personal injury. Traditional reinsurance capacity could not be found to back this policy, so the SPV Operational Re was registered in Bermuda.

Operational Re was one of the few bond issues to be downsized during marketing, down from CHF700m to CHF220m (~$223m), due to lack of support from ILS investors, despite the very high attachment point of CHF3.2bn in annual aggregate losses under the Zurich International insurance policy. There is also a per-event limit on qualifying losses of CHF3bn, so it would take at least two qualifying losses to cause a loss to the Operational Re bonds.

After a number of restructurings of the offer, the final placed structure of the 5-year bond was in three tranches:

- Junior tranche of CHF110m Class B notes, with an expected loss of 0.15% (a 1-in-1200 risk) and coupon of 5.5% (for an exceptionally high multiple of 36.67)
- Two senior tranches of $105m Class A-1 and $5m of Class A-2, both with expected losses of 0.2% and coupons of 4.5% (multiple of 22.5)

The high multiples reflected the difficulty in assessing such a wide-ranging and novel operational risk cover.

Motivation: The Operational Re deal is reported to have allowed Credit Suisse to reduce its Risk Weighted Assets (RWA) by CHF1.15bn.

There have been a number of attempts over the years to develop insurance policies to cover financial institutions operational risks, with the objective of reducing the amount of risk-weighted capital a bank would be required to hold on its balance sheet to meet regulatory solvency requirements. These attempts have generally failed because regulators have been unwilling to accept insurance as a substitute for Tier III capital, citing uncertainty over timing and amount of collecting insurance recoveries.

Outcome: Two years later Zurich International sponsored Operational Re II (2018) placing a further CHF146m of 3-year bonds, in the same three tranches and topping up the protection provided by Operational Re (2016), to give a total of CHF366m (~$377m) – with both bonds maturing in April 2021.

Operational Re III (2020) was the third bond in the series, providing $461.22m of cover over 3.75 years, split over eight tranches with coupons between 5.5% and 3.8%.

Cat bonds covering life & health risks

C

Deal 18: Vita Capital (2003) / Swiss Re – first excess mortality risk cat bond

[Structuring: Swiss Re Capital Markets]

Structure: Vita Capital raised $400m principal-at-risk notes, with a 3-year maturity, to provide its Sponsor, Swiss Re, with coverage against extreme mortality exposures (such as a lethal pandemic). The notes were rated 'A+' by S&P and 'A3' by Moody's, and priced at Libor+135bps. The trigger was a combined mortality index, similar to other index-based cat bonds. The mortality index was a weighted combination of public mortality data from five selected countries – France, Italy, Switzerland, UK and US. The notes attached if during any of the three covered years, the combined mortality index exceeded 130% of the baseline 2002 level; the principal repaid at maturity would be reduced by 5% for each 1% of the index exceeding the 130% threshold, and hence no principal would be repaid if the index exceeded 150%.

Outcome: Vita Capital was the first in a series of now eight extreme mortality bonds issued by Swiss Re, one approximately every two years (the latest being Vita Capital VI in 2021), raising a total of $2.422bn between them. Several other insurance companies have also issued extreme mortality cat bonds, including Munich Re, Minnesota Life Insurance, Reinsurance Group of America, Axa Global Life and SCOR Global Life.

Deal 19: Vitality Re (2010) / Aetna Life – first medical benefits cat bond

[Placement: Goldman Sachs; Risk modelling: Milliman]

Structure: Vitality Re provided $150m of indemnity cover for a 3-year term against the claims payments made by Health Re (Aetna's reinsurance SPV), and the bonds were rated 'BBB-' by S&P (citing pandemic as the biggest risk of loss to this transaction). In more detail, Aetna secured surplus capital relief by entering into a quota share reinsurance agreement with Health Re Inc, a special purpose insurance captive, newly formed in Vermont. At the same time, Health Re entered into a 3-year, indemnity-based, annual aggregate excess of loss reinsurance agreement with Vitality Re Limited, a newly formed Cayman Islands insurance company. Vitality Re then issued $150m of notes to collateralise and fund its obligations under its reinsurance agreement with Health Re, and the notes were sold to Goldman Sachs, who in turn then sold them to institutional investors.

The trigger is the medical benefit loss ratio (MBR), the ratio of claims to premium, calculated on an annual aggregate basis. The attachment point was an MBR of 104%, with Aetna receiving the full $150m if the MBR reached the exhaustion point of 114%. These MBR figures would be reset each year to maintain a constant risk profile for investors.

Motivation: The motivation for the Vitality Re transaction was primarily that it improved Aetna's capital efficiency and reduced their weighted cost of capital, rather than to secure reimbursement of paid losses.

Outcome: Aetna Life followed up Vitality Re (2010) with three further 3-year bonds, issuing one each year from 2011 to 2013 (named Vitality Re II to Vitality Re IV), each again for $150m, with various attachment and exhaustion points. Aetna then followed up further with nine 4-year bonds, issuing one each year from 2014 to 2022 (named Vitality Re V to Vitality Re XIII), this time each for $200m – giving a total of $2.4bn over the series so far.

Deal 20: Kortis Capital (2010) / Swiss Re – first longevity risk cat bond

[Structuring & placement: Swiss Re Capital Markets; Risk modelling: RMS]

Structure: The $50m of securities issued by Kortis Capital were at risk of an improvement of the mortality of a UK cohort (males aged 75 to 85) over a US cohort (males aged 55 to 65), over eight years from 2009 to 2016. Any loss under the bond was linked to how much an index of longevity (the UK cohort living relatively longer than the US cohort) exceeded a set attachment point.

Outcome: It is not known publicly if there have been any further longevity risk cat bonds; the longevity risk transfer market is active, but most of the deals undertaken by pensions funds or life insurance companies are structured as longevity swaps and/or reinsurance.

Deal 21: IBRD CAR 111-112 (2017) / World Bank Pandemic Emergency Financing Facility (PEF) – first pandemic cat bond

[Co-structurers: Swiss Re Capital Markets & Munich Re Capital Markets; Modeller: AIR Worldwide; Bookrunner: Swiss Re Capital Markets; Co- Managers: Munich Re Capital Markets & GC Securities]

Structure: Issued in July 2017 through the International Bank for Reconstruction and Development (IBRD) global debt facility, these two series of pandemic Capital-at-Risk cat bonds (CAR Series 111 and CAR Series 112) would provide cash to the Pandemic Emergency Financing Facility (PEF) in its work to help countries or regions that experience a pandemic to manage its spread and subsequent recovery. The parametric triggers for both tranches were based on the World Health Organisation (WHO) reported deaths, rate of spread and crossing borders; both tranches provided coverage on an occurrence basis for a 3-year term (extendable monthly, up to a maximum of 12 months).

The lower-risk Series 111 Class A tranche provided $225m of cover for outbreaks of pandemic flu or coronavirus events. The higher-risk Series 112 Class B tranche provided $95m of cover against a wider range of perils: Coronaviridae (SARS, MERS), Filoviridae (Ebola, Marburg), and other zoonotic diseases (Crimean Congo Haemorrhagic, Lassa and Rift Valley Fevers). The World Bank also sold $105m of pandemic linked catastrophe swaps to capital market investors, giving an overall total of $425m.

Loss experience: The Ebola pandemic (a Filovirus) in the democratic Republic of Congo in 2018 passed the trigger point in terms of the number of deaths in December 2018, and then passed across the border to Uganda in June 2019 – but the third element of the trigger, i.e. rate of spread, was not met, and so the Series B notes were not triggered in the end.

With the COVID-19 pandemic, the number of deaths (initially in China) trigger was reached by February 2020, and then the progressive world-wide spread trigger being reached by February/March 2020, and the rate of spread trigger by April 2020. This resulted in a $95m payment to the PEF of 100% of the Class B cat bonds tranche (plus $55m from the Class B swaps); additionally the Class A cat bonds made a $37.5m payment (plus $8.34m from the Class A swaps) – in each case this was due to the 16.67% sub-limit on the Class A cat bonds and swaps for a coronavirus outbreak. Thus the total payment from the bonds and swaps was $195.84m, which was used to help some of the poorer nations of the world with their response to the COVID pandemic, and these payments were made in early May 2020 (just within the original 3-year term).

Other IBRD issues: The World Bank, through the IBRD, has now sponsored a number of cat bonds.

"$225m of cover for outbreaks of pandemic flu or coronavirus events ... $95m of cover against a wider range of perils: Coronaviridae (SARS, MERS), Filoviridae (Ebola, Marburg), and other zoonotic diseases (Crimean Congo Haemorrhagic, Lassa and Rift Valley fevers"

In 2017 the IBRD / FONDEN (2017) issue comprised three tranches, IBRD CAR 113, 114 and 115, of cat bonds, providing a total of $360m of protection. All three tranches provided protection on a parametric trigger basis, with the level of pay-out (25%, 50%, 75%, or 100%) linked to boxes for each peril, and where and how powerful any earthquake or named storm strikes Mexico. The Series 113 Class A $150m 3-year notes provided parametric earthquake protection; the Series 114 Class B $100m 3-year notes provided protection against named storms on the Atlantic coast; the Series 115 Class C $110m 3-year notes provided protection against named storms on the Pacific coast.

A magnitude 8.1 earthquake on 8 September 2017 off the coast of Mexico was of sufficient epicentre location, depth and intensity to trigger the full $150m pay-out of the Series 113 Class A bonds.

In 2018 the IBRD issued five tranches providing a total of $1.36bn earthquake cover for the four Pacific Alliance countries (Chile, Colombia, Mexico, Peru) on a parametric basis (including magnitude, epicentre location, depth, etc.). The bonds, their duration and sizes were as follows:

- CAR 116 – Chile, 3-years, $500m
- CAR 117 – Columbia, 3-years, $400m
- CAR 118 & CAR 119 – Mexico, 2-years, two tranches of $160m & $100m respectively
- CAR 120 – Peru, 3-years, $200m

Peru experienced a magnitude 8.0 earthquake on 26 May 2019 in a parametric zone where a magnitude 7.8 to 8.1 would trigger a 30% pay-out. This $60m pay-out was duly made within 25 days of the occurrence of the earthquake.

The IBRD replaced the expiring IBRD / FONDEN (2017) bonds and the expiring CAR 118 and CAR 119 bonds with a new IBRD / FONDEN (2020) bond to provide Mexico with $485m of 4-year earthquake and named storm cover in four tranches – $175m Class A for lower-risk earthquake, $60m Class B for higher-risk earthquake, $125m Class C for named storms on the Atlantic coast, and $125m Class D for named storms on the Pacific coast. All the bonds have similar parametric box structures to their predecessors.

IBRD also issued two cat bonds in October 2019 for the Treasury of the Republic of the Philippines, both providing 3-year cover on a modelled loss basis. The $75m IBRD CAR 123 Class A bonds are exposed to Philippine earthquake risks, and the $150m IBRD CAR 124 Class B bonds to Philippine tropical cyclone risks.

Finally, for the time being, IBRD issued the $185m IBRD CAR 130 bond for 2.5 years of cover for Jamaican named storms, based on a parametric box structure using the National Hurricane Centre's automated cyclone forecasting system.

The World Bank has also designed and used another structure for disaster risk financing, called a Catastrophe Deferred Drawdown Option (Cat DDO). This is detailed later under the Contingent Capital section (see Deal 24).

Tailpiece on losses suffered by non-property catastrophe bonds

There have been very few losses of principal suffered by non-property cat bonds. The loss experience of the Avalon Re (2005) bond issued by OCIL has been detailed above, under Deal 12, with an estimated loss of $135m out of the total $150m principal. Swiss Re's Crystal Credit (2006) Class C bonds suffered a complete loss of principal, and the Class B bonds a partial loss, giving an estimated combined $174m loss of principal from credit insurance claims as a result of the Global Credit crisis in 2008.

Reinsurance sidecars

D

Deal 22: K-Cover (1994) / Hannover Re – the first private insurance-linked securitisation transaction

Structure: Hannover Re had a top-level natural catastrophe facility K-Cover, which was heavily reliant on retrocession parties. In late summer 1993 Eberhard Müller (Managing Director of the Group Risk Management Division of Hannover Re) was taking a ride on the London Underground from London Heathrow Airport to the City when he mused that:

> *"I found it increasingly difficult to find retrocessional capacity for shares half a percent, one percent, and so on, and to do all the accounting – especially in case of losses for all those partners – so I thought it might be a good idea to have one big player, perhaps outside of the insurance industry, to agree with those outside players to retrocede a major piece of the business with one single partner doing all the accounting and having security already on hand. That was the initial idea."*[19]

It would need to be a player with a big enough balance sheet and sufficient credit rating to, in effect, 'front' the program. In due course, this is what was achieved with Citibank, creating the first private catastrophe $85m bond transaction K-Cession in March 1994.

Outcome: The K series of transactions has remained a key part of Hannover Re's retro program ever since, being renamed K-Cession in 2015 and described as "the backbone of our retrocession program"[20]. In 2020 the K-Cession quota share retro sidecar program, placed largely with third-party capital, was for $680m – the largest in the series to date; reduced to $619m in 2021, and $450m in 2022. Hannover Re also uses the ILS market for other retro protection covers – Eurus (2006), Eurus II (2009) and Eurus III (2012) were two 3-year and one 4-year parametric cat bonds providing cover for European windstorm, and 3264 Re (2020-1) is a 3-year industry loss index cat bond covering US named storm, US and Canadian earthquake and European windstorm – and Hannover Re also issued a series of L1 to L4 Life reinsurance cat bonds, in collaboration with the RISConsulting Group, over the period 1998 to 2000 – with Rabobank providing the financing for L1 to L3, and a consortium of European banks provided the financing for L4.

Deal 23: Flatiron Re (2005) / Arch Capital – one of the first large fully-collateralized reinsurance sidecars

[Sponsors: Goldman Sachs, Farallon Capital]

The ILS vehicles that have come to be known as reinsurance sidecars were first formed in Bermuda in 2005 with Montpelier Re's $91m Rockridge Re in June 2005 and four others in December 2005. The largest of these was Flatiron Re, formed by Arch Capital with capital of $840m.

Structure: Arch Capital used its Bermudian subsidiary Arch Re to form Flatiron Re (2005), which provided a 45% quota share protection in certain lines of property and marine business written by Arch Capital. Flatiron Re was entirely owned by outside investors and wrote fully-collateralized business exclusively for Arch Capital.

19 GR interviews: the man who invented cat bonds, Global Reinsurance, 17 April 2014

20 From a 2015 interview with Artemis on www.artemis.bm/news/k-cessions-quota-share-sidecar-the-backbone-of-our-retrocession-hannover-re/

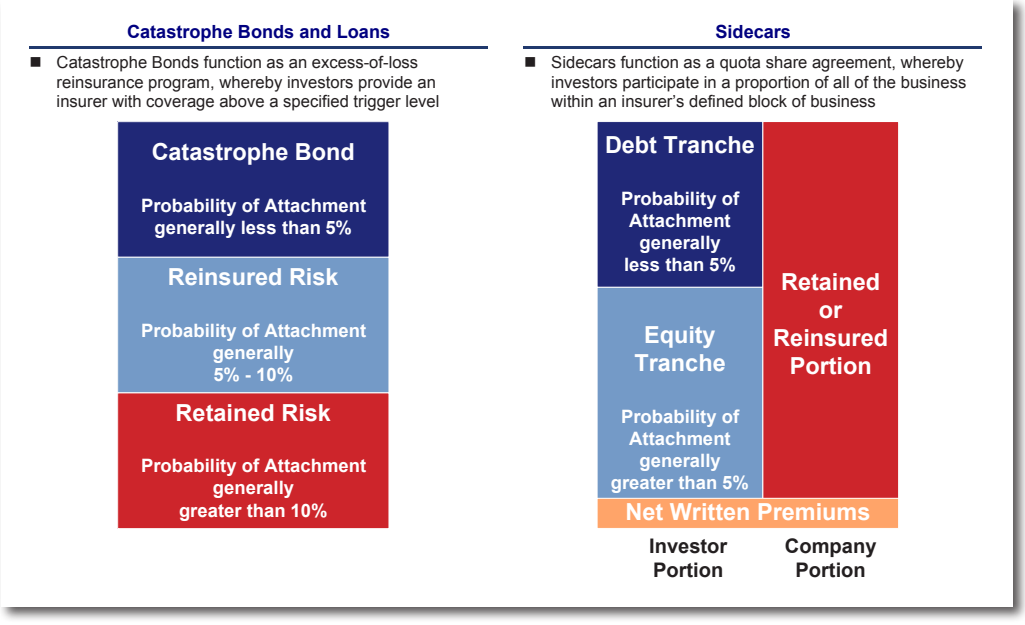
Outcome: Flatiron Re (2005) remained the largest reinsurance sidecar for some time until it was exceeded by Everest Re's Mt Logan series, which reached ~$885m with Mt Logan Re (2015), then $949m with Mt Logan Re (2017) and $1.03bn with Mt Logan Re (2018), which was finally topped by Swiss Re's Sector Re (2019) with ~$1.1bn.

Other reinsurance sidecars

The Artemis "Deal Directory – Reinsurance Sidecars" lists 194 sidecars up to the end of 2020, but many entries are renewals of existing sidecars (as sidecars typically have a tenure between one and two years) and so there are a little more than 50 unique Sponsors.

Tailpiece on the naming of sidecars

Some of the names given to sidecars are interesting. Brit Ltd called their 2006 sidecar Norton Re (after the classic British manufacturer of motorbikes), followed by Paris Re calling their 2006 sidecar Triomphe Re (presumed to be a reference to the Arc de Triomphe, but when the author inquired, he was told it was after another classic British motorbike manufacturer, Triumph). Other Sponsors have honoured Scientists – Renaissance Re has formed several sidecars, including Fibonacci Reinsurance (2006) and DaVinci Re (2011), and Hamilton Re formed Turing Re (2017). Everest Re has gone, more predictably, with highest mountains, with its sidecar series named Mt Logan (2013 onwards) and its cat bond series Kilimanjaro (2014 onwards). One of main motivations for creating a sidecar is to allow the Sponsor to write more business, and with annual renewals to have a flexible capacity provider, able to be expanded and contracted in response to market conditions – hence my prize for most aptly named sidecar goes to Lancashire Holdings' sidecars called Accordion Reinsurance (2011 & 2012).



Comparison of Catastrophe Bonds and Sidecars

Source: Goldman Sachs

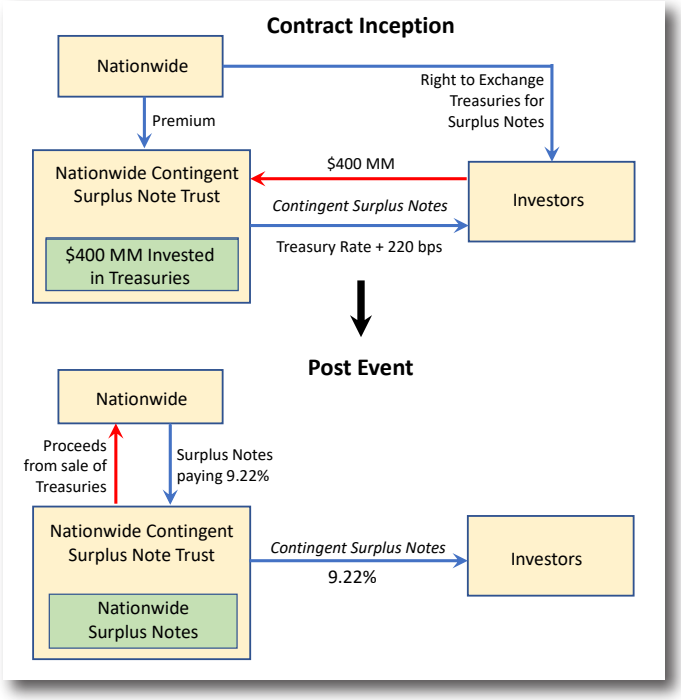
Contingent capital

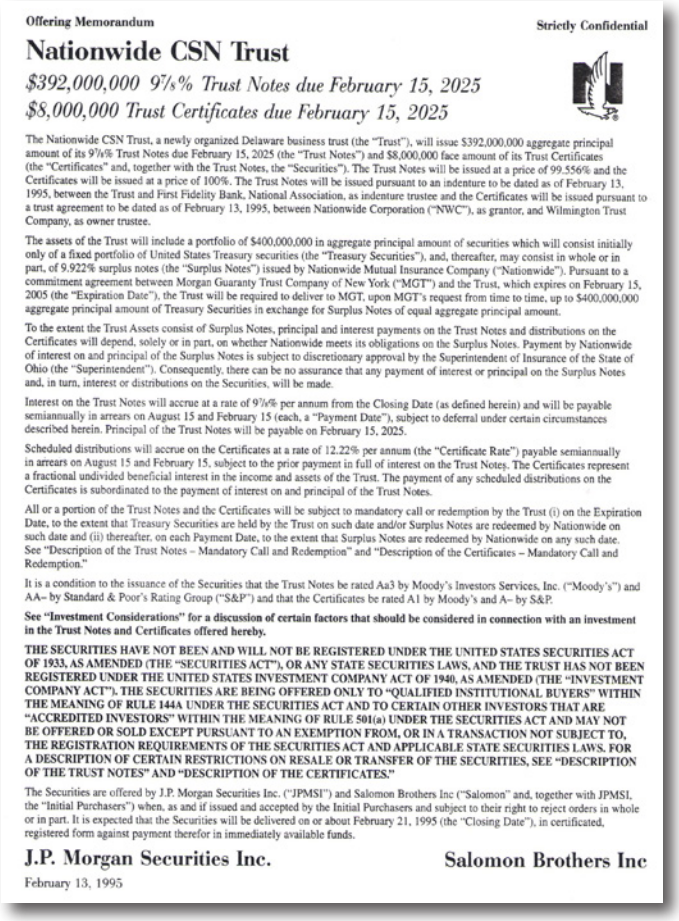
E

Also dating back just over 25 years are two contingent surplus note (CSN) issuances by US mutual insurance companies, Nationwide Mutual Insurance (1995) and Arkwright Mutual Insurance (1996). Mutual insurance companies only have limited access to capital raising, unlike the various alternatives available to listed (re)insurance companies.

Under the February 1995 Nationwide Mutual Company of Ohio deal, $400m was raised and placed in the newly formed Nationwide CSN Trust. Investors in the 10-year trust fund received a coupon equal to the yield on US Government bonds plus $2^{3}/_{8}$%. Nationwide could draw down cash from the trust fund under wide conditions, by converting it into surplus notes (much like preference shares). The risk that the investors ran was that Nationwide did not pay the dividends on these surplus notes; the primary risk was that any dividend payment by a mutual insurance company has to be approved by the State regulator, and that for some reason the Ohio State regulator prohibited Nationwide making such a payment to investors (the regulator is obliged to put the interest of policyholders in mutual insurance company paramount). Although there was no reinsurance contract between Nationwide and the trust fund, Nationwide used its access to the cash as an alternative to reinsurance and ceased its purchase of traditional reinsurance – treating the trust fund as contingent capital.

Arkwright Mutual completed a similar $100m deal in May 1996.





Offering Memorandum — Strictly Confidential

Nationwide CSN Trust

$392,000,000 9⅞% Trust Notes due February 15, 2025
$8,000,000 Trust Certificates due February 15, 2025

The Nationwide CSN Trust, a newly organized Delaware business trust (the "Trust"), will issue $392,000,000 aggregate principal amount of its 9⅞% Trust Notes due February 15, 2025 (the "Trust Notes") and $8,000,000 face amount of its Trust Certificates (the "Certificates" and, together with the Trust Notes, the "Securities"). The Trust Notes will be issued at a price of 99.556% and the Certificates will be issued at a price of 100%. The Trust Notes will be issued pursuant to an indenture to be dated as of February 13, 1995, between the Trust and First Fidelity Bank, National Association, as indenture trustee and the Certificates will be issued pursuant to a trust agreement to be dated as of February 13, 1995, between Nationwide Corporation ("NWC"), as grantor, and Wilmington Trust Company, as owner trustee.

The assets of the Trust will include a portfolio of $400,000,000 in aggregate principal amount of securities which will consist initially only of a fixed portfolio of United States Treasury securities (the "Treasury Securities"), and, thereafter, may consist in whole or in part, of 9.922% surplus notes (the "Surplus Notes") issued by Nationwide Mutual Insurance Company ("Nationwide"). Pursuant to a commitment agreement between Morgan Guaranty Trust Company of New York ("MGT") and the Trust, which expires on February 15, 2005 (the "Expiration Date"), the Trust will be required to deliver to MGT, upon MGT's request from time to time, up to $400,000,000 aggregate principal amount of Treasury Securities in exchange for Surplus Notes of equal aggregate principal amount.

To the extent the Trust Assets consist of Surplus Notes, principal and interest payments on the Trust Notes and distributions on the Certificates will depend, solely or in part, on whether Nationwide meets its obligations on the Surplus Notes. Payment by Nationwide of interest on and principal of the Surplus Notes is subject to discretionary approval by the Superintendent of Insurance of the State of Ohio (the "Superintendent"). Consequently, there can be no assurance that any payment of interest or principal on the Surplus Notes and, in turn, interest or distributions on the Securities, will be made.

Interest on the Trust Notes will accrue at a rate of 9⅞% per annum from the Closing Date (as defined herein) and will be payable semiannually in arrears on August 15 and February 15 (each, a "Payment Date"), subject to deferral under certain circumstances described herein. Principal of the Trust Notes will be payable on February 15, 2025.

Scheduled distributions will accrue on the Certificates at a rate of 12.22% per annum (the "Certificate Rate") payable semiannually in arrears on August 15 and February 15, subject to the prior payment in full of interest on the Trust Notes. The Certificates represent a fractional undivided beneficial interest in the income and assets of the Trust. The payment of any scheduled distributions on the Certificates is subordinated to the payment of interest on and principal of the Trust Notes.

All or a portion of the Trust Notes and the Certificates will be subject to mandatory call or redemption by the Trust (i) on the Expiration Date, to the extent that Treasury Securities are held by the Trust on such date and/or Surplus Notes are redeemed by Nationwide on such date and (ii) thereafter, on each Payment Date, to the extent that Surplus Notes are redeemed by Nationwide on any such date. See "Description of the Trust Notes – Mandatory Call and Redemption" and "Description of the Certificates – Mandatory Call and Redemption."

It is a condition to the issuance of the Securities that the Trust Notes be rated Aa3 by Moody's Investors Services, Inc. ("Moody's") and AA– by Standard & Poor's Rating Group ("S&P") and that the Certificates be rated A1 by Moody's and A– by S&P.

See "Investment Considerations" for a discussion of certain factors that should be considered in connection with an investment in the Trust Notes and Certificates offered hereby.

THE SECURITIES HAVE NOT BEEN AND WILL NOT BE REGISTERED UNDER THE UNITED STATES SECURITIES ACT OF 1933, AS AMENDED (THE "SECURITIES ACT"), OR ANY STATE SECURITIES LAWS, AND THE TRUST HAS NOT BEEN REGISTERED UNDER THE UNITED STATES INVESTMENT COMPANY ACT OF 1940, AS AMENDED (THE "INVESTMENT COMPANY ACT"). THE SECURITIES ARE BEING OFFERED ONLY TO "QUALIFIED INSTITUTIONAL BUYERS" WITHIN THE MEANING OF RULE 144A UNDER THE SECURITIES ACT AND TO CERTAIN OTHER INVESTORS THAT ARE "ACCREDITED INVESTORS" WITHIN THE MEANING OF RULE 501(a) UNDER THE SECURITIES ACT AND MAY NOT BE OFFERED OR SOLD EXCEPT PURSUANT TO AN EXEMPTION FROM, OR IN A TRANSACTION NOT SUBJECT TO, THE REGISTRATION REQUIREMENTS OF THE SECURITIES ACT AND APPLICABLE STATE SECURITIES LAWS. FOR A DESCRIPTION OF CERTAIN RESTRICTIONS ON RESALE OR TRANSFER OF THE SECURITIES, SEE "DESCRIPTION OF THE TRUST NOTES" AND "DESCRIPTION OF THE CERTIFICATES."

The Securities are offered by J.P. Morgan Securities Inc. ("JPMSI") and Salomon Brothers Inc ("Salomon" and, together with JPMSI, the "Initial Purchasers") when, as and if issued and accepted by the Initial Purchasers and subject to their right to reject orders in whole or in part. It is expected that the Securities will be delivered on or about February 21, 1995 (the "Closing Date"), in certificated, registered form against payment therefor in immediately available funds.

J.P. Morgan Securities Inc. — **Salomon Brothers Inc**

February 13, 1995

The National Mutual Contingent Surplus Note Transaction

Source: Issues Paper on Non-Life Securitisation, International Association of Insurance Supervisors (IAIS), October 2003

Deal 24: RLI Corp Catastrophe Equity Put, CatEPut^{sm} (1995) / Centre Re – the first contingent capital transaction by an insurance company

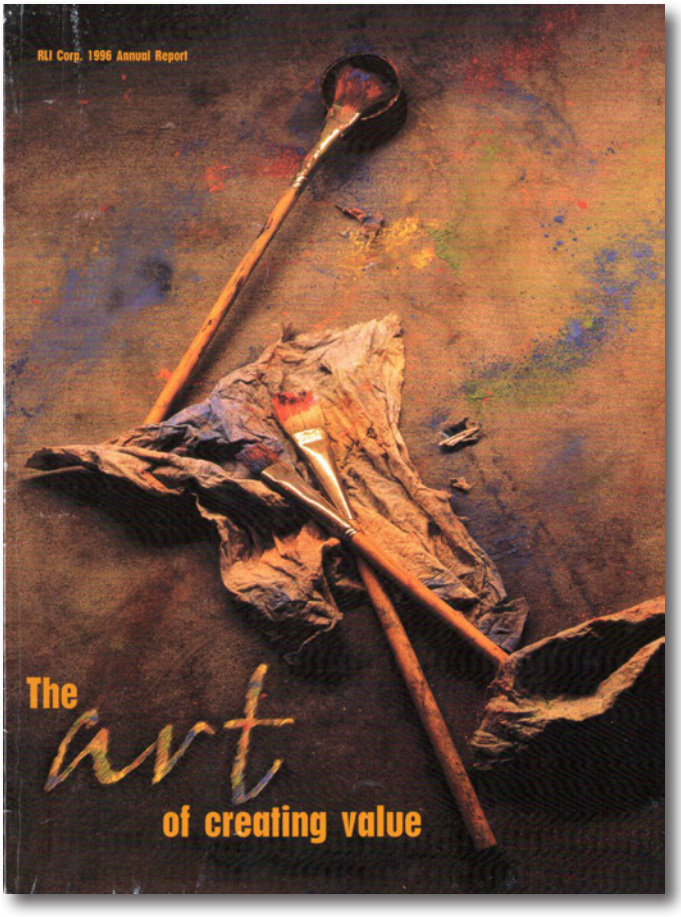
Bryon Ehrhart (of Aon Re Services) was painting his house one day and his mind got to wondering if and how a company could short its own shares. This thought process eventually led to Aon devising a contingent capital structure, named a Catastrophe Equity Put, and service marked as CatEPut^{sm}. The first client to issue a CatEPut was RLI Corp, a Californian-based company that had suffered large losses from the Northridge earthquake in 1994, that went through the top of its reinsurance program.

Structure: The RLI Corp CatEPut was a 3-year option agreement with a capital provider, in this first case Centre Re. RLI paid an annual option premium to Centre Re; the option would be triggered by a major Californian earthquake event. Once triggered then:

- Centre Re buys up to $50m convertible non-voting preferred shares in RLI
- RLI pays annual dividends to Centre Re on these preferred shares
- Unless redeemed earlier, RLI converts 50% of these preferred shares at a pre-agreed price into full-voting common equity after 3 years, and the remaining 50% after 4 years
- Centre Re is then free to hold or sell this common equity on the open market

There were a number of covenants to the agreement, mainly that RLI continued to buy reinsurance up to its previous limit (the CatEPut in effect provided an additional layer of 'super' reinsurance) and that RLI was judged to be a 'going concern'.

The main benefit to RLI of the CatEPut was that, post-event, it received an infusion of up to $50m (the amount would be determined on an indemnity basis, i.e. the same amount as if RLI had purchased an equivalent layer of reinsurance) of capital to the Balance Sheet. This would help preserve RLI's ability to continue to write catastrophe earthquake insurance, at a time when any such triggering event (in effect a 'Northridge Mark II') would naturally lead to much higher premium rates – enabling RLI to earn enough premium to subsequently buy back the preferred shares it had issued to Centre Re. This feature of protecting the Balance Sheet led to RLI's credit rating being increased by a notch.



Another benefit was that the annual CatEPut option premium was significantly less than annual premium RLI were quoted at the time for an equivalent $50m layer of reinsurance (around $4m). This illustrates the dilutive effect of upper layer reinsurance; the probability assessment of a loss sufficient to trigger the CatEPut was 1-in-75 years, i.e. 1.33%. Whereas the reinsurance rate on line was $4m premium for $50m limit, i.e. 8% - a 6 times multiple of the expected loss (as layers of reinsurance become higher the premium is driven ever more by the cost of risk capital required to write the policy rather than the expected losses under the policy).

However, this is not quite comparing 'apples with apples', because the CatEPut in effect provides a loan of up to $50m (secured by the issuance of preferred shares), but contractually repayable none the less, whereas receipt of any reinsurance recovery does not lead to any contractual

payback (although reinsurance premium rates might well increase over subsequent years). Also the CatEPut does not have any reinstatement provisions, once the $50m has been received there is no access to any further funds from Centre Re during the balance of the 3-year period of the agreement (unless a completely new agreement is entered into), whereas a reinsurance policy will often provide for one or more reinstatements of the policy limit under pre-defined terms and conditions. Finally, the CatEPut does not provide any protection to the Profit & Loss (P&L) account – in the event of any 'Northridge Mark II' type event, RLI would record a $50m hit to the P&L with no reinsurance recovery to offset it (the $50m receipts going straight onto the Balance Sheet).

Nevertheless, RLI Corp considered that the CatEPut protected shareholder value and included the following in its 1996 Annual Report & Accounts, entitled "The art of creating value":

Q: What are the benefits (of the CatEPut) to shareholders?

A: First, this is an extremely cost-effective level of security ... a fraction of the price for a similar layer of reinsurance.

But by improving our ability to withstand a momentous catastrophic event, we have also fortified shareholder value. Even if such a disaster occurs, our earning power would remain intact at its current level. Likewise the ability of RLI to pay dividends and rise in value has also been shielded.

"by improving our ability to withstand a momentous catastrophic event, we have also fortified shareholder value. Even if such a disaster occurs, our earning power would remain intact at its current level"

Outcome: RLI renewed the CatEPut transaction several times, with Zurich Insurance being the counterparty in latter times, Zurich being granted the additional option (in the event of the CatEPut being triggered) to reinsure certain business written by RLI on a prospective basis.

Aon also placed CatEPut deals for a number of insurance company clients, Horace Mann Educators Corp (1997) – counterparty was again with Centre Re - and LaSalle Re (1997) – with counterparties Allianz, European Re (a subsidiary of Swiss Re), Continental Casualty and CIC Hillsdale – and LaSalle Re (1999) – with counterparties Allianz and European Re. The LaSalle Re (1999) CatEPut had an unhappy outturn:

- Trenwick acquired LaSalle Re and the CatEPut in September 2000 (extract from Form 10-K405 Lasalle Re Holdings Limited, dated 2001-04-02)

  In addition, as part of the Company's capital protection strategy, the Company utilized a Catastrophe Equity Put ("CatEPut") option program since July 1, 1997. The CatEPut option was a capital replacement tool that enabled the Company to put a pre-arranged amount of equity, through the issue of convertible preferred shares to the option writers at pre-negotiated terms, in the event of a major catastrophe or series of large catastrophes that cause substantial losses to the Company or its subsidiaries. After the Business Combination with Trenwick, although the CatEPut remained in effect with the same triggers, the issuer of the convertible preferred shares changed from LaSalle to the publicly traded Trenwick.
- Allianz terminated its obligation under the CatEPut in January 2001
- the World Trade Centre catastrophe in September 2001 caused significant losses to Trenwick
- Trenwick and Swiss Re had to go to arbitration in July 2002 before Swiss Re agreed to buy $44m of Trenwick shares in September 2002
- and then in August 2003 Trenwick filed for Chapter 11 bankruptcy

Swiss Re also placed a very similar contingent capital structure, **Committed LOng-term Capital Solutions (CLOCS)**, for a variety of financial institutions and corporate clients – most notably Compagnie Financière Michelin, whose mid-2000s CLOCS deal had a parametric trigger. The Michelin deal replaced a 15-year $1bn subordinated loan with a 12-year $1.1bn subordinated capital facility, giving Michelin guaranteed access to a bank credit facility and the option to draw on an insurance facility if the combined average annual growth rates of Michelin's main markets (Europe and the US) fell below a predetermined level. The contingent capital facility was syndicated across a range of European banks and (re)insurers. Thus Michelin had the discretion to draw on this facility in whatever way would best help it weather a depressed market – such as affording restructuring costs if it had to retrench, or make acquisitions whilst stock prices were low, or neutralize the financial/economic impact of the crisis in whatever way best placed Michelin to benefit from any subsequent GDP recovery. A potentially 'aggressive' form of risk financing, rather than the more usual 'defensive' nature of insurance.

Contingent capital deals for insurance companies continued during the mid-2000s onwards, including XL Capital / Stoneheath Re (2006), Hartford / Glen Meadow (2007), Lancashire (2007) / JP Morgan, Endurance (2007) / Deutsche Bank, Farmers Insurance (2007, 2012 and 2015) underwritten by a consortium of banks and Swiss Re, Florida State (2008) / Berkshire Hathaway, and Allianz (2011). These deals could be triggered by one or more insured property catastrophe events and were on an indemnity basis.

SCOR has also entered into four contingent capital transactions. The first was in 2010 with UBS, providing €150m contingent preferred stock over 3 years in two €75m tranches, providing cover against one large catastrophe or a series of losses above certain thresholds. The series of losses sustained in Q1 2011 by SCOR in Australia, New Zealand and Japan, and topped up by further losses in Q2 2011, resulted in one €75m tranche of shares being issued to UBS in July 2011. SCOR topped up its protection by entering into a further €75m facility in May 2012, to restore the total cover to €150m. When these deals matured, the SCOR (2014) transaction renewed and extended the facility to provide €200m of widened cover, by also including extreme mortality events, and the SCOR (2017) renewal was increased to €300m, with BNP Paribas as the new counterparty, and the SCOR (2019) renewal was again for €300m but this time with J. P. Morgan as the counterparty.

As mentioned above, the World Bank has also designed and used another structure for disaster risk financing, called a Catastrophe Deferred Drawdown Option (Cat DDO), which is a contingent line of credit for governments. The Cat DDO provides rapid access to financing in the event of a disaster of a pre-defined magnitude or impact occurring; it is a contingent loan, and has to be repaid, but at attractive terms. An early Cat DDO was a $500m facility for the Philippines in 2015; $496.25m of this facility was drawn down in 2018 to support the Philippine Government's recovery efforts, rehabilitation and reconstruction following typhoon Mangkhurt in mid-September that year.

Other countries to secure a Cat DDO, a contingent line of credit, more recently, include $150m for the Dominican Republic in 2017, $200m for Kenya in 2018, $10m for the Maldives in 2019, $50m for Madagascar in 2019, $275m for Morocco in 2019, $10m for Vanuatu in 2020 and $20m for Grenada in 2020.

Deal 25: Swiss Re (2013) – contingent capital transaction with a parametric trigger

Structure: Swiss Re issued $750m of contingent notes (rated BBB+) in April 2013. The innovative feature was that these notes had a parametric structure, being triggered if Swiss Re's solvency (as measured by the Swiss Solvency Test – SST) fell below 125%. Thus it provided very broad balance sheet protection, not just limited to catastrophe property losses but covering anything that adversely impacted Swiss Re's solvency level – underwriting losses across any and all classes of business, investment performance, etc.

Outcome: Swiss Re followed this with two further contingent capital deals with parametric triggers. In September 2013 Swiss Re issued CHF175m (~$193m) of contingent notes with a dual trigger structure, being triggered by either a 1-in-200 Atlantic hurricane, or Swiss Re's solvency (SST) falling below 135%. In June 2018 Swiss Re issued a further $500m of contingent notes with a trigger of Swiss Re's solvency (SST) falling below 160%. This approach to risk financing gives much broader balance sheet protection and resilience by focussing on the impact of events, rather than more narrowly just on specified causes.

Contingent capital deals are off-balance sheet and allow companies "to tap capital in those times when it normally would be difficult and costly to raise it traditionally"[21] – quotation taken from an article appropriately entitled "Just-in-Case Capital". Such structures are more efficient than raising and servicing paid-up capital that turns out not be necessary.

Deals combining contingent capital with cat bonds

One early transaction that combined contingency and cat bond features was the Reliance National III Optionable Note (1998) . Reliance National had issued two earlier cat bonds. Reliance National (1997), the first cat bond to cover multiple lines of business other than property, advised by Sedgwick Lane Financial and INSTRAT (UK). This was followed by Reliance National II (1998), which covered five separate business lines, each of which exposed 20% of the investor's capital.

The Reliance National III contingent debt option entitled it to issue cat bonds at any time during the 1998-2000 period. It also covered five lines of business: US Property, Rest of World Property, Aviation, Offshore Marine, and Satellite Launch Failure. Reliance National paid an option premium to obtain the right to acquire coverage, on pre-specified terms, when it needed the coverage – in effect the deal provided a 'price cap' on future reinsurance cover.

Allianz Risk Transfer, sponsored by Goldman Sachs, placed a similar structure through an SPV, the $150m Gemini Re putable cat bond (1999) with a 3-year option period.

21 Peter Currie, CFO of Royal Bank of Canada in article "Just-in-Case Capital" published in CFO magazine, June 2001

Concluding remarks

Cat bonds and other Insurance-Linked Securities differ from traditional reinsurance in various respects. Features of ILS structures include:

- Usually multi-year (typically between three and five years) – but no reinstatement of limits following qualifying losses
- Have employed a variety of trigger mechanisms, indemnity and non-indemnity (including parametric, modelled loss and industry loss); non-indemnity triggers include basis risk
- Pricing mainly driven by technical factors (model results such as expected losses), rather than (re)insurance 'cyclical' market conditions
- Fully collateralised
- Variety of transfer and financing structures, and now not limited to single catastrophe events – but some cat bonds now include multi-perils on either a single occurrence or aggregate basis. For example, the AIG Tradewynd 2013 and 2014 cat bonds provide coverage on a portfolio of insurance risks and are reminiscent of the deal we started with, George Town Re

The advantages and disadvantages of ILS structures versus traditional reinsurance are given in the following table.

	Advantages	Disadvantages
Traditional Reinsurance	**Very responsive** – deals can be agreed swiftly with a longer term client retention drive (relationship emphasis)	**Credit risk of reinsurance failure**
	Indemnity based – avoids basis risk and has a proven track record in indemnity-based covers	**High frictional costs** – brokerage etc
	Broad range of coverage available – a diversified book, covering all lines of business, regions & perils and an ability to cover long-tail business and natural events with long development pattern	**Volatility in pricing and capacity**
	Dependent on cycle but pricing can be more competitive than capital markets – open to multi-year covers and reinstatements, flexibility with terms and conditions (inc cyber/terror covers in nat cat treaties)	**Disputes** – emergence of "can pay, won't pay" culture?
Securitisations	**No credit risk** – fully collateralised security	**Slow development time** – bespoke transactions typically take months to construct
	Greater stability in pricing – lower, more stable prices	**Basis risk** from parametric and index triggers
	Avoids reinsurance disputes	**Capacity still restricted for cat risk (US Property Cat) & retrocession**
	Potential for far greater capacity	**Secondary market needed to increase liquidity/reduce costs etc**
		High frictional costs – advisory fees etc

Perspectives and incentives: traditional reinsurance versus securitisations

Source: "Alternative Sources of Capital", Daniela Collis & Sie Liang Liu, SCOR Global P&C Asia Pacific, 3-4 March 2016

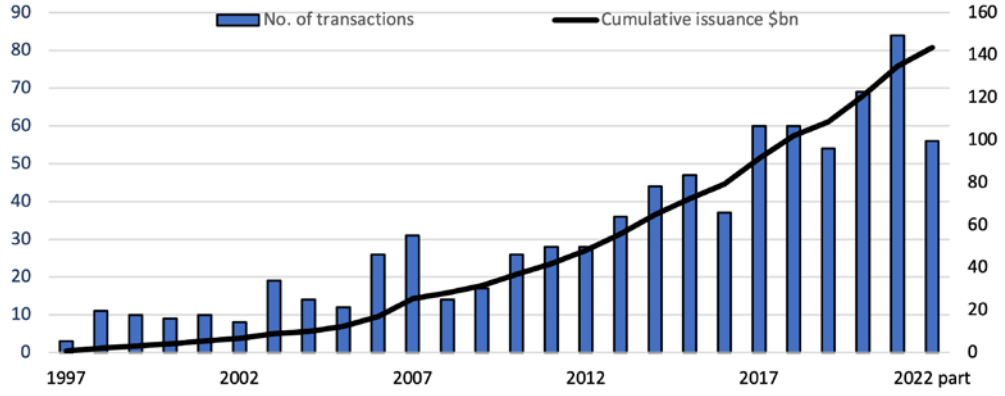
The advantages and disadvantages of ILS structures, from both issuer and sponsor perspectives, are given in the following table.

	Advantages	Disadvantages
Sponsor	**(Currently low) pricing** - capital influx and low conventional investment returns have driven the price of both CAT Bonds and traditional reinsurance to historic lows	**No reinstatements** (unless transformer is involved)
	Can fit comfortably within an existing CAT XL reinsurance program	**Basis risk** exists for all triggers (unless a transformer is involved) – although significantly less for Indemnity triggers
	More efficient access to capital than untimely liquidation and repatriation of overseas investments at a time of need – e.g. after 2011 Tohoku EQ and tsunami in Japan	**Long term corporate relationship with investors not very important (although important with transformer)**
	Reduced capital charges in internal Capital Model reflecting both immediate capital access via collateralization ("cash in bank" versus a promise of indemnification)	
	Greater bargaining power arising from **investor oversubscription** -> now easier to sponsor indemnity CAT bonds	
Investors	**Diversifying asset class** compared with conventional investment types (equities, fixed income) (and hence markets are less susceptible to systemic failure)	Oversubscription **reduces spread** over benchmark, **EL multiple** and **bargaining power** on types of trigger
	Relatively high yields (historic) compared with current conventional risk-free fixed income universe	**Potentially delayed return of capital**; **litigation** may result whenever a partial or total loss to a CAT bond
	Low volatility (historic)	**Market has yet to be tested by "the big one"**

Perspectives and incentives: sponsor versus investors

Source: "Alternative Sources of Capital", Daniela Collis & Sie Liang Liu, SCOR Global P&C Asia Pacific, 3-4 March 2016

All the ILS structures continue to evolve and become an ever more important part of the (re)insurance landscape. The following chart shows the growth year-by-year in the number of cat bonds issued and the cumulative amount of risk capital they represent.



Catastrophe Bond growth

Finally, cat bonds and other ILS risk capital structures are securities, and subject to Securities law, and are not reinsurance contracts. Documentation, due diligence, etc. are all more onerous and the penalties for any infractions are much more serious. Cat bonds and other ILS structures should only be issued and traded by parties with the relevant securities licensing and registration.

Appendix 1: Lists of cat bonds issued by corporations and public/ government entities

Most sponsors of ILS are (re)insurance companies, but a number of corporations (see Table 1A) and other non-insurance company entities (see Table 1B) have issued catastrophe bonds.

Table 1A - Catastrophe bonds issued by corporations (up to end June 2022)

	Sponsor	SPR	Duration	Amount	Peril	Trigger	Date of issue
1	Oriental Land	Concentric Re	5 years	$100m	Japanese earthquake	Parametric	May 1999
2	Vivendi Universal SA	Studio Re	3½ years	$175m	California earthquake	Parametric	Dec 2002
3	Electricité de France (EDF)	Pylon	5 years	$228m	Windstorm – transmission & distribution (T&D)	Parametric	Dec 2003
4	FIFA	Golden Goal	3 years	$262m	2006 World Cup cancellation	Parametric	Sep 2003
5	Dominion Resources	Drewcat Capital	6 months	$50m	Gulf of Mexico windstorm	Parametric	Jun 2006
6	East Japan Railway Company	Midori	5 years	$260m	Japanese earthquake & BI	Parametric	Oct 2007
7	*Electricité de France (EDF)	Pylon II Capital	~5 years	$216m	Windstorm – transmission & distribution (T&D)	Parametric	Aug 2011
8	MyLotto24	Hoplon Insurance	3 years	$101m	Lottery winnings	Indemnity	Sep 2011
9	New York City Metropolitan Transit Authority (MTA)	MetroCat Re	3 years	$200m	New York (named) storm surge	Parametric	Jul 2013
10	*MyLotto24	Hoplon II Insurance	3 years	$67m	Lottery winnings	Indemnity	Aug 2014
11	Kaiser Permanente	Acorn Re	3 years	$300m	US west coast earthquake	Parametric	Jul 2015
12	Amtrak	PennUnion Re	~3 years	$275m	Storm surge, named windstorms & earthquake	Parametric	Oct 2015
13	Credit Suisse	Operational Re	5 years	$222m	Operational risk	Indemnity	May 2016

	Sponsor	SPR	Duration	Amount	Peril	Trigger	Date of issue
14	*New York City Metropolitan Transit Authority (MTA)	MetroCat Re	3 years	$125m	New York (named) storm surge & earthquake	Parametric	May 2017
15	*MyLotto24	Hoplon III Insurance	2 years	€20m	Lottery winnings	Indemnity	Feb 2018
16	*Credit Suisse	Operational Re II	~3 years	$148m	Operational risk	Indemnity	Jun 2018
17	PG&E Corporation	Cal Phoenix Re	3 years	$200m	Third-party liability resulting from California wildfire	Indemnity	Aug 2018
18	Sempra Energy	SD Re	3 years	$125m	Third-party liability resulting from California wildfire	Indemnity	Oct 2018
19	*Credit Suisse	Operational Re III	3¾ years	$461m	Operational risk	Indemnity	Apr 2020
20	*New York City Metropolitan Transit Authority (MTA)	MetroCat Re	3 years	$100m	New York (named) storm surge & earthquake	Parametric	May 2020
21	*Sempra Energy	SD Re	3 years	$90m	Third-party liability resulting from California wildfire	Indemnity	Jul 2020
22	Alphabet Inc	Phoenician Re	3 years	$237.5m	California earthquake	Indemnity	Dec 2020
23	*Alphabet Inc	Phoenician Re	3 years	$95m	California earthquake	Indemnity	Dec 2020
24	*Sempra Energy	SD Re	3 years	$180m	Third-party liability resulting from California wildfire	Indemnity	Oct 2021
25	Prologis, Inc	Logistics Re	3 years	$95m	US earthquake	Indemnity	Dec 2021
26	*Alphabet Inc	Phoenician Re	3 years	$237.5m	California earthquake	Indemnity	Dec 2021
	Total			**$10,368m**			

** = repeat issue*

Apart from being fully collateralised and multi-year (as are most cat bonds), the other distinguishing features of the catastrophe bonds issued to date by corporations are:

A. The peril(s) covered does not have to be conventional mainstream insurable risks – cat bonds have been issued covering some 'difficult to insure' risks such as non-damage business interruption, event cancellation, transmission & distribution, storm surge, temperature and operational risk.

B. They have almost all had parametric triggers and settlement structures, i.e. the physical parameters of the covered event alone are used to determine the size of any

settlement (and not any consideration of indemnity). Of the exceptions, indemnity is clearly the most appropriate structure for the three Hoplon bonds for covering lottery winnings, and the two Golden State Re bonds are classified as modelled, but the model is driven by the event parameters entered into it, such as the day of the week and time of day. The other bonds to have an indemnity trigger are the three Credit Suisse bonds, which provide cover for an Operational Risk insurance policy, the PG&E and three Sempra Energy bonds that cover for losses suffered by third parties as a result of the operations of the energy companies, and finally, the three Alphabet bonds that are accessing the capital markets to provide reinsurance cover for Alphabet's captive insurance company.

Table 1B – Catastrophe bonds issued by government entities and others (to end June 2022)

	Sponsor	SPR	Duration	Amount	Peril	Trigger	Date of issue
1	FONDEN	Cat-Mex	3 years	$160m	Mexican earthquake	Parametric	May 2006
2	*FONDEN	MultiCat Mexico 2009	3 years	$290m	Mexican hurricane & earthquake	Parametric	Oct 2009
3	California State Compensation Insurance Fund (SCIF)	Golden State Re	3 years	$200m	Workers' compensation resulting from earthquake	Modelled	Dec 2011
4	Turkish Catastrophe Insurance Pool (TCIP)	Bosphorus 1 Re	3 years	$400m	Earthquake, Istanbul region	Parametric	Apr 2013
5	World Bank	CCRIF (Caribbean Catastrophe Risk Insurance Facility)	3 years	$30m	Caribbean hurricane & earthquake**	Parametric	Jun 2014
6	*California State Compensation Fund (SCIF)	Golden State Re II	3 years	$250m	Workers' compensation resulting from earthquake	Modelled	Sep 2014
7	Turkish Catastrophe Insurance Pool (TCIP)	Bosphorus	3 years	$100m	Earthquake, Istanbul region	Parametric	Aug 2015
8	FONDEN / AGROASEMEX S.A.	IBRD / FONDEN 2017	3 years	$360m	Mexico earthquakes & named storms	Parametric	Aug 2017
9	FONDEN / AGROASEMEX S.A.	IBRD CAR 118-119	2 years	$260m	Mexico earthquake	Parametric	Feb 2018
10	*California State Compensation Fund (SCIF)	Golden State Re II	4 years	$210m	Workers' compensation resulting from earthquake	Modelled	Nov 2018
11	Pool Re	Baltic PCC	3 years	$97m	Terrorism	Indemnity	Feb 2019
12	FONDEN / AGROASEMEX S.A.	IBRD / FONDEN 2020	4 years	$485m	Mexico earthquakes & named storms	Parametric	Mar 2020

	Sponsor	SPR	Duration	Amount	Peril	Trigger	Date of issue
14	Los Angeles Department of Water & Power	Power Protective Re	3 years	$50m	California wildfire	Parametric	Dec 2020
15	Danish Red Cross	Dunant Re IC	3 years	$3m	Volcanic eruption	Parametric	Mar 2021
16	*Los Angeles Department of Water & Power	Power Protective Re	3 years	$30m	California wildfire, property and third party liability	Indemnity	Oct 2021
17	*Pool Re	Baltic PCC	3 years	$131m	Terrorism	Indemnity	Mar 2022
	Total amount			**$8,930m**			

** = repeat issue*
*** = payment made to Belize in Aug 2016*

The majority of these bonds issued on behalf of non-(re)insurance companies have covered natural disaster perils (i.e. earthquake & hurricane), and have also had parametric triggers. This is likely because the primary concern of any public entity or governmental agency after a disaster is quick access to cash to conduct disaster recovery operations and to provide funds to reinstate (uninsured) infrastructure.

Appendix 2: Reference material

For news stories, commentary and details of ILS transactions see the website **www.artemis.bm** (you can sign up for a free weekly newsletter). The website also contains many other items of detail including a Cat bonds and ILS Deal Directory, Cat bond and ILS Market Statistics, a List of Reinsurance Sidecars, a List of Longevity Risk Transfer Transactions, Artemis Conference Reports, and much other ILS market information.

Market reviews: The major reinsurance companies and brokers and other consultants produce regular quarterly and/or annual reports on the ILS market, all available free on the respective company website; these include (latest editions at time of writing):

- Aon Securities – www.aon.com
  - ILS Annual Report 2021
  - Insurance-Linked Securities, Aon Securities Q1 2022 Update
- Artemis - www.artemis.bm
  - Q2 2022 Catastrophe Bond & ILS Market Report
- Guy Carpenter (GC Securities) – www.guycarp.com
  - GC Capital Ideas Blog
- Lane Financial LLC - www.lanefinancialllc.com
  - Quarterly Market Performance Report – Q3 2021, 30 September 2021
  - Annual Statistical Review for the Four Quarters, Q2 2020 to Q1 2021, 31 March 2021
- Swiss Re - www.swissre.com
  - Insurance-Linked Securities Market Insights: Vol XXXV, August 2021
- Willis Re Securities - www.willistowerswatson.com
  - 2020 Global Insurance-Linked Securities Market Survey Report, 8 November 2020

Many companies actively involved in the ILS market have produced publications on various ILS topics, including the following, each available free on the respective company website:

- The picture of ART, Swiss Re, sigma, No. 1/2003
- Capital market innovation in the insurance industry, Swiss Re, sigma, No. 3/2001
- Securitisation - new opportunities for insurers and investors, Swiss Re, sigma, No. 7/2006
- The fundamentals of insurance-linked securities, Swiss Re, 2011
- Cat Bonds Demystified: RMS guide to the asset class, 2012
- So you want to issue a cat bond, by David A. Lalonde and Brent Poliquin, AirCurrents, 02/2012, Air Worldwide
- A Balanced Discussion on Insurance-Linked Securities, PartnerRe, Research & Publications, 2008
- Reinsurance vs. Catastrophe Bonds, Towers Watson, 2012

A number of industry or international bodies have produced reports examining aspects of the ILS sector (all available on the internet):

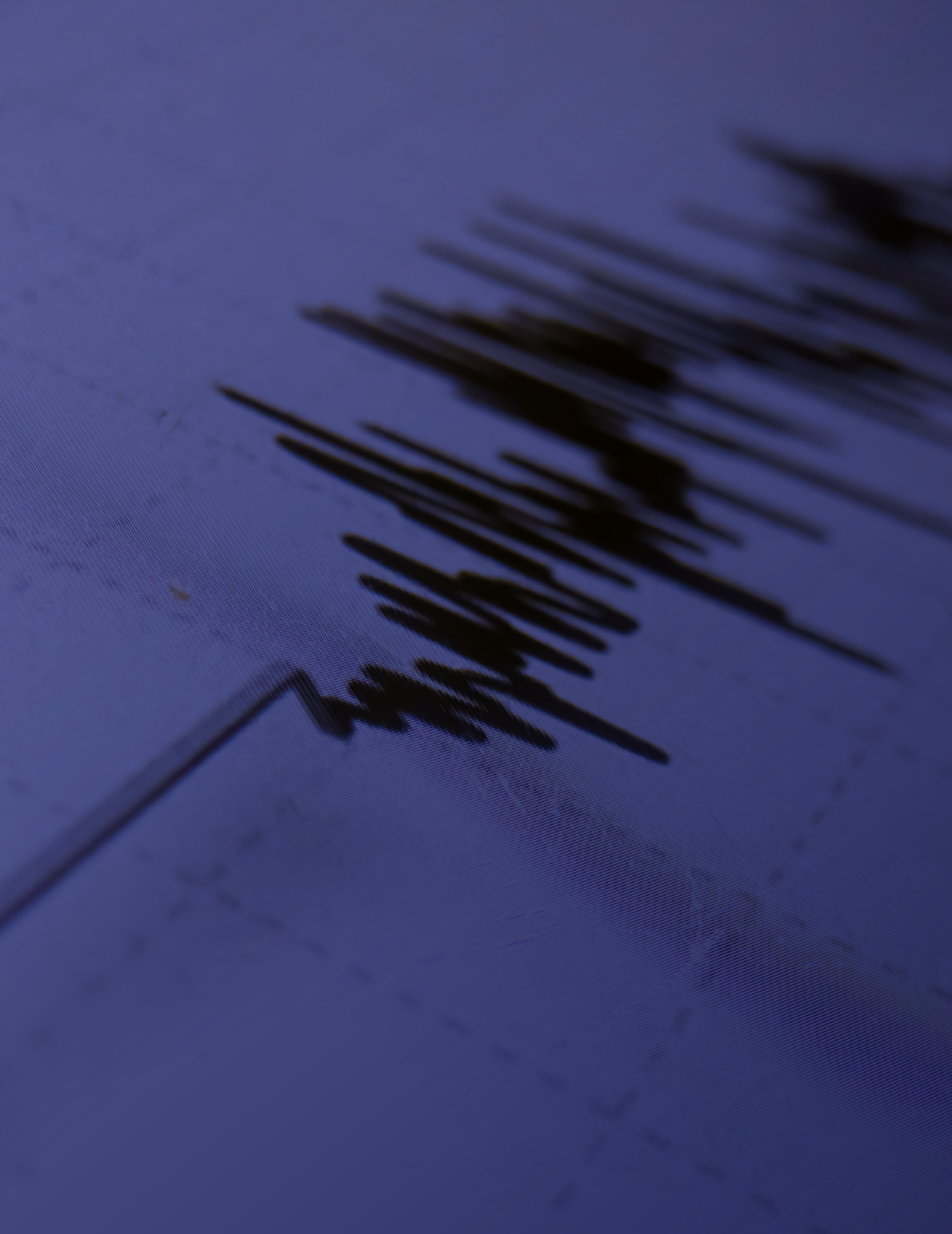
- Convergence of Insurance and Capital Markets, World Economic Forum, October 2008
- Insurance-Linked Securities Report, Committee of European Insurance and Occupational Pensions Supervisors, CEIOPS-DOC-17/09, June 2009
- Developments in (Re)Insurance Securitisation, International Association of Insurance Supervisors (IAIS), 26 August 2009
- Issues paper on non-life securitisation, International Association of Insurance Supervisors (IAIS), October 2003
- Issues paper on life securitisation, International Association of Insurance Supervisors (IAIS), October 2003

More specialist articles on specific ILS structures include:

- Insurance of the future – CatEPut[SM], by Bryon Ehrhart and Alan Punter, The Treasurer, July/August 1997
- Contingent Covers, by Bryon Ehrhart, Chapter 7 Risk Swaps, Yuichi Takeda, Chapter 5 in Alternative Risk Strategies, edited by Morton Lane, Risk Waters Group, 2002
- Innovative financing: Life insurance securitization, PricewaterhouseCoopers, November 2005
- Of Sidecars and Such by Morton N Lane of Lane Financial LLC, 31 January 2009
- Sidecars, by Andre Perez, in Alternative (Re)insurance Strategies (Second edition), edited by Morton Lane, Risk books, 2012
- Industry Loss Warranties, by Eric Manning, in Alternative (Re)insurance Strategies (Second edition), edited by Morton Lane, Risk books, 2012
- A Legal Guide to Industry Loss Warranty Contracts, Ince & Co, 2013
- Risk Swaps, by Yuichi Takeda, Chapter 5 in Alternative Risk Strategies, edited by Morton Lane, Risk Waters Group, 2002

There are several specialist books covering ILS and related topics:

- Securitized Insurance Risk: Strategic Opportunities for Insurers and Investors, edited by Michael Himick and Sylvie Bouriaux, Glenlake Publishing, 1998
- Alternative Risk Strategies, edited by Morton Lane, Risk Waters Group, 2002
- Alternative Risk Transfer: Integrated Risk Management through Insurance, Reinsurance and Capital Markets, Erik Banks, Wiley Finance, 2004
- The Handbook of Insurance-Linked Securities, edited by Pauline Barrieu and Luca Albertini, Wiley Finance, 2009
- Alternative (Re)insurance Strategies (Second edition), edited by Morton Lane, Risk books, 2012



A Celebration of 25 years of Insurance-Linked Securitisation **through 25 Landmark Deals**

The devastation caused by Hurricane Andrew in August 1992 alerted the (re)insurance industry that it may not have the capital base in the future to cope with multiple insured disasters of this magnitude. This triggered the search to find new contractual structures and financial instruments to transfer the insured cost of catastrophes into the broader and deeper capital markets.

Over the following 25 years a number of solutions to this problem have been implemented. They are broadly categorised under the heading of Insurance-Linked Securitisation (ILS). The most successful of these has been the transformation of insurance risk into a security, issued into and tradable in the capital markets, the so-called Catastrophe (or simply Cat) Bonds. Similar to other Government and Corporate Bonds, Cat bonds have the additional feature of a default provision contingent upon the occurrence of one or more pre-defined events. The original Cat Bonds covered natural catastrophes, such as windstorms (hurricanes & typhoons) and earthquakes. Over the years the range of perils covered by Cat Bonds has widened beyond property catastrophe classes, to include other non-life classes such as motor and credit, and also life perils, such as excess mortality and longevity. Other ILS structures to have evolved include contingent capital transactions and sidecar vehicles.

Approaching 1,000 cat bonds have now been issued over the 25 years since 1992, and this book celebrates the development of ILS by reviewing 25 landmark transactions, covering Cat Bonds and other ILS structures, that have shaped the development of this now major component of the (re)insurance market.

The author Dr Alan Punter BTech, MSc, PhD, MBA has had a career combining academia and working in the (re)insurance industry, specialising in the areas of risk management and alternative risk financing, from Captives through to Cat bonds. Working for Aon, his roles included being CEO of Aon Capital Markets Ltd up to his retirement. He was also a Visiting Professor at Bayes (formerly Cass) Business School in London for many years, lecturing Masters' courses on Risk Management, Alternative Risk Transfer and Insurance-Linked Securitisation. He has written texts and study materials on Risk Management, and spoken frequently at international industry conferences. Alan is still involved in the industry as an NED of Occam Underwriting and an active Liveryman of the Worshipful Company of Insurers.

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