



International Network on the Financial Management of Large-Scale Catastrophes

Draft Report

**CATASTROPHE-LINKED SECURITIES
AND CAPITAL MARKETS**

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CATASTROPHE-LINKED SECURITIES AND CAPITAL MARKETS

1. Introduction¹

Catastrophe-linked securities are a financial tool to transfer CAT risks to capital markets

Catastrophe-linked (“CAT-linked”) securities provide a mechanism for the transfer of catastrophe risks to capital markets, and may provide an additional layer of protection to traditional insurance and reinsurance arrangements or serve to reduce reliance on these arrangements. CAT-linked securities may also create opportunities for the transfer of catastrophe risks that are currently not covered by insurance markets, thus potentially broadening the overall financial coverage of such risks.

As capital markets have a potentially huge capacity to absorb catastrophe risks, CAT-linked securities may enhance the ability of the financial system, and economic actors more broadly, including governments, to manage the costs of natural and man-made catastrophes. In the recent years, the transfer of the higher layers of disaster risks, often referred to as “peak risks”, to capital markets has been considered by public and private sector participants in the context of integrated catastrophe risk management strategies.

CAT-linked securities appeared in the aftermath of Hurricane Andrew in 1992 in the belief that the capacity offered by the traditional reinsurance market and the retrocession market would shrink. The Chicago Board of Trade (“CBOT”) launched futures and options contracts with payouts linked to the U.S. industry catastrophe losses. Securitisation of catastrophe risk² in the form of catastrophe (“CAT”) bonds appeared soon thereafter with the first experimental offering of CAT bonds in 1994.

The CAT bond market

According to Guy Carpenter, during the past decade the CAT bond market followed a steady growth path and reached its peak at the end of 2007, when the total amount of CAT bond risk capital outstanding³ was US\$13.8 billion, a

¹ This paper was prepared, in large part, by Prof. Richard MacMinn and Prof. Sylvie Bouriaux of Illinois State University. Members of the High-level Advisory Board, the OECD Secretariat (Timothy Bishop) and Prof. Alberto Monti of Bocconi University contributed to its drafting.

² The term “securitisation” is used in a very broad sense in this paper to mean the conversion of (credit, interest-rate, catastrophe, etc) risks into marketable securities (e.g., bonds, derivative instruments). According to the International Association of Insurance Supervisors (IAIS), the term “securitisation” involves a simple financial concept: “the future cash flows that can be expected from a particular source (e.g., receivables or loan repayments) serve to back up a financial instrument for sale to an investor. When a business entity (originator) engages a securitisation, it first transforms the cash flows into a tradable instrument and then transfers the attendant risk from the entity to capital market investors who, in turn, expect a return commensurate with the risks.” [Source: IAIS, *Issues paper on non-life insurance securitisation*, October 2003].

³ Total risk capital outstanding is the total bond principal at risk in the market, irrespective of issuance year. See *The Catastrophe Bond Market at Year-End 2007: The Market Goes Mainstream*, Guy Carpenter, LLC, 2008, p.6.

started in the mid nineties and, following a growth path, it reached its peak in 2007

63 percent increase over US\$8.5 billion in 2006, and nearly three times the US\$4.9 billion outstanding at the end of 2005. As of year-end 2007, CAT bond risk principal composed 8 percent of the estimated property limits globally and 12 percent on a U.S.-only basis.⁴ Total value of new issues in 2007 amounted to US\$7 billion, a notable increase compared to US\$4,69 billion in 2006, US\$1,99 billion in 2005 and US\$1,14 billion in 2004.

CAT bond issuances fell in 2008 partly due to the global financial crisis and partly due to favourable conditions in the traditional reinsurance market

After this record-setting year, in 2008 CAT bond issuances fell 62 percent by volume (US\$2.7 billion in new and renewal capacity) and 52 percent by transaction count (13), with the vast majority of transactions taking place in the first two quarters. Towards the end of the year, planned CAT bond transactions were postponed partly because of the impact of the global financial crisis on secondary market spreads, and partly because of concerns over the effectiveness of the collateral protection mechanics embedded in CAT bond structures.⁵ The enhanced capacity and favourable rates in the traditional reinsurance market also contributed to this trend. In consideration of the above, as well as of the fact that that US\$4.7 billion in risk capital disappeared as 24 CAT bonds were redeemed according to their contractual terms, at the end of 2008 the total amount of outstanding CAT bond risk capital dropped to US\$11.8 billion, a 14.5 percent decrease from 2007.⁶

New CAT bonds featuring improved structures and tighter collateral requirements were issued in 2009, but prices have significantly increased

New CAT bonds featuring improved structures and tighter collateral requirements were issued in 2009: while previous CAT bond transactions used a total return swap (“TRS”)⁷ counterparty – usually an investment bank – to guarantee the collateral pool backing the bonds, most recent deals impose strict prudential rules on how the collateral is invested, feature daily mark-to-market accounting on the collateral accounts and “top up” requirements in the event that asset values fall below par. These new structures also feature improved transparency and easier access to information on the underlying assets, as well as contractual mechanics to facilitate the replacement of the swap counterparty or to unwind the transaction in case of default, with a view to better protecting the interests of investor and sponsor. Notwithstanding significantly increased

⁴ Ibid, p.3.

⁵ During the last quarter of 2008, in fact, a number of CAT bonds have been directly hit by the global credit crisis, due to the loss of their total return swap (“TRS”) counterparty as a result of the failure of Lehman Brothers.

⁶ See GC Securities, *Cat Bonds Persevere in Tumultuous Market*, February 2009, available at: <http://www.gccapitalideas.com/2009/02/04/cat-bonds-persevere-in-tumultuous-market/>

⁷ A TRS converts the interest earned on the collateral investments to a LIBOR or EURIBOR basis, and the swap counterparty assumes the credit risk and the liquidation/spread risk of the underlying assets. In other words, the swap counterparty guarantees both the LIBOR or EURIBOR based interest rate and the full return of principal. Thus, principal default would occur only if both the counterparty and the collateral defaulted. See IAIS, *Issues paper on non-life insurance securitisation*, October 2003, p. 13.

⁸ Price sensitivity has already manifested itself in the CAT bond market this year: some transactions were postponed because of cost, while others were replaced with capital from other sources such as Industry Loss Warranties (ILWs). See GC Securities, *Cat Bond Update: First Quarter 2009*, April 2009, available at: <http://www.gccapitalideas.com/2009/04/13/cat-bond-update-first-quarter-2009/>

⁹ According to Guy Carpenter and other market sources, a return to the pace of 2007 is unlikely, but 2009 is nonetheless expected to be a busy year for the CAT bond market. See GC Securities, *Cat Bond Update: First Quarter 2009*, cit.

CAT-linked derivatives may offer interesting alternatives to reinsurance and CAT bonds

prices,⁸ after a six-month halt the CAT bond market seems to be resurging in this first half of the year 2009.⁹

In the time immediately preceding the current financial crisis, CAT-linked derivatives instruments had re-emerged, after a period of quiet in derivatives market following the CBOT's failed attempt in generating insurer and investor interest in exchange-traded derivatives. Three futures exchanges – the New York Mercantile Exchange (“NYMEX”), the Chicago Mercantile Exchange (“CME”), and the Insurance Futures Exchange Services (“IFEX”) – re-introduced exchange-traded CAT-linked futures and options contracts. Each exchange is seeking to capitalise on a perceived larger appetite for CAT-linked products by investors and an expected increasing need for risk transfer by insurers and reinsurers.

In the first half of 2009, demand for disaster derivatives – such as Industry Loss Warranties (“ILWs”) and CAT futures – has been surging as insurers seek alternatives to scarce reinsurance and expensive CAT bonds, especially in anticipation of the North Atlantic hurricane season.

What could be the role of capital markets in financing the cost of large-scale natural catastrophes?

The High-level Advisory Board (“Advisory Board”) to the OECD International Network on the Financial Management of Large-Scale Catastrophes, with the support of the Insurance and Private Pensions Committee and the Committee on Financial Markets, has followed these developments and identified the role of capital markets in the financing of large-scale natural catastrophes as meriting policy attention among OECD and non-OECD countries. The Advisory Board considers that CAT-linked securities may provide a useful tool in the financial management of large-scale catastrophes by offering an alternative risk transfer instrument for insurers, reinsurers, governments and corporations seeking to transfer CAT risks, and thus enhancing the capacity of these entities to bear such risks. This is especially important in light of the increasing costs of catastrophes due to several factors, including the impact of climate change on extreme weather events. The Advisory Board expressed particular interest in identifying possible impediments to the growth of CAT-linked capital market instruments and considering possible solutions, if any.

Convergence of insurance and capital markets

In this regard, it shall be noted that the topic of convergence of insurance and capital markets was very recently addressed in a comprehensive report published by the World Economic Forum (“WEF Report”).¹⁰ The WEF Report, focusing on insurance-linked securities (“ILS”) and building on previous research work conducted, *inter alia*, by the International Association of Insurance Supervisors (“IAIS”)¹¹, starts from the observation that while the potential capacity offered by global investors is vast, insurance risks still lack a liquid, transparent and tradable market. With a view to identifying key issues¹²

¹⁰ See *Convergence of Insurance and Capital Markets*, World Economic Forum, October 2008, available at: <http://www.weforum.org/pdf/ip/fs/ConvergenceReport.pdf>

¹¹ See: IAIS, *Issues paper on non-life insurance securitisation*, October 2003; IAIS, *Issues paper on life insurance securitisation*, October 2003. Most recently: IAIS, *Developments in (re)insurance securitisation*, August 2009. See also: Swiss Re Sigma, *Securitization – New Opportunities for Insurers and Investors*, n.7/2006; Swiss Re Sigma, *The role of indices in transferring insurance risks to the capital markets*, n.4/2009.

¹² According to the WEF Report, in order to develop a market for ILS the following issues must be addressed in a multi-year time horizon: lack of standardisation; insufficient cost/benefit analysis; poor data quality; basis

and possible solutions to stimulate growth of a global ILS market – which is implicitly considered as a desirable goal – the WEF Report makes an important point in that it recognises that there are notable distinctions between the securitisation of *assets* and the securitisation of *liabilities*. While most life insurance securitisations – backed by the embedded value of future profit streams – are structurally similar to asset-backed securities (“ABS”),¹³ the case of non-life (e.g., property and casualty) securitisation is very different. Since the typical property and casualty (“P&C”) portfolio consists of a wide spectrum of uncorrelated risks, creating diversification benefits, non-life insurers have limited incentives to transfer these risks to the market. Moreover, from a legal perspective, insurers cannot be removed from the risk equation since they must respond directly to their policyholders. Insurers, therefore, are in a position to use ILS to transfer risk and obtain additional financial capacity,¹⁴ but not to adopt an aggressive “originate and transfer” model similar to the one that characterised the sub-prime lending practice and related mortgage-backed securities (“MBS”) market in the United States.¹⁵

risk; limited secondary market; complexity of risk valuation and uncertainties concerning the probability of catastrophic loss.

¹³ “While there are risk transfer securitisations in life business that protect against catastrophic mortality risk, the majority of life securitisations to date have been designed to generate present cash flow against the amortisation of statutory and technical provisions. These have been termed “embedded value securitisations” [Source: IAIS, *Issues paper on non-life insurance securitisation*, October 2003, p. 4]. See also IAIS, *Issues paper on life insurance securitisation*, October 2003; Swiss Re Sigma, *Securitization – New Opportunities for Insurers and Investors*, n.7/2006.

¹⁴ As acknowledged by the IAIS (*Issues paper on non-life insurance securitisation*, October 2003), securitisations can provide non-traditional sources of capital market financing, thus complementing and supplementing traditional debt and equity financing available to a business. For the insurance and reinsurance businesses, in particular, the securitisation concept has proven to provide an attractive alternative source of capacity, since CAT bond investors for the most part do not also provide traditional (re)insurance protection. See also: Swiss Re Sigma, *Securitization – New Opportunities for Insurers and Investors*, cit., pp. 3 ff.

¹⁵ In other words, while in the context of a MBS, the originator of a mortgage loan can completely remove itself from the risk equation, an insurance/reinsurance company issuing ILS remains directly liable vis-à-vis the policyholder/primary insurer. This may inhibit the growth of the market for ILS, but it may also avoid distorted incentives of the type that contributed to the sub-prime lending crisis in the United States.

¹⁶ The public sector is directly concerned with the economic coverage of disaster losses for several reasons: the financial impact of a disaster on individuals and businesses may be significant, which could lead to large welfare losses and have broad macroeconomic consequences; public assets, including buildings and infrastructures, are exposed to risk and whose destruction or impairment may have economic impacts; finally, in the aftermath of a catastrophe, the public authority will likely be under strong political pressure – or sometimes even under a legal duty – to provide compensation to victims. See Monti A., *Policy Approaches to the Financial Management of Large-Scale Disasters*, in ‘Financial Management of Large-Scale Catastrophes’, Policy Issues in Insurance n.12, OECD Publishing, 2008.

¹⁷ With some notable exceptions, such as the parametric catastrophe bond issued by the Mexican government in 2006 to cover certain financial consequences of catastrophic earthquake risks and the recently established Caribbean Catastrophe Risk Insurance Facility (CCRIF), sovereign sponsored transactions are still relatively uncommon. CAT bonds were nevertheless used in the past by the Taiwan Residential Earthquake Insurance Fund (TREIF), a governmental entity. In a number of emerging countries, moreover, capital market solutions, including multi-country multi-peril catastrophe bonds, are currently being considered to cover the cost of emergency relief measures and damages to public infrastructures and lifelines due to a disaster.

Development of CAT-linked securities from a public policy angle

The issues and questions surrounding the potential future development of CAT-linked securities acquire special interest if addressed from a public policy angle and in the context of disaster risk management strategies developed at national or regional level.

Integrated disaster risk management strategies

Confronted with the growing impact of natural hazards, governments in OECD countries have in recent years adopted policies aimed to enhance disaster risk awareness, preparedness, prevention, mitigation and response and, consequently, to reduce vulnerability and exposure to natural hazards. The adoption of such policies, however, can only diminish the direct and indirect costs of extreme natural events, but cannot completely eliminate such costs.

Economic coverage of disaster losses

The economic coverage of disaster losses, therefore, constitutes a key policy issue for governments and it concerns: (i) the cost of emergency rescue, response and relief measures aimed at saving lives and providing temporary assistance to the population hit by a disaster event; (ii) damages to public assets and critical infrastructure; (iii) property damages, including reconstruction costs, and economic losses suffered by businesses and individuals affected by a disaster.¹⁶

Possible uses of CAT-linked securities by governments

Since the availability of financial compensation and risk transfer tools *ex ante* may enhance economic efficiency and performance, CAT-linked securities attract the attention of policymakers not only because they may be able to significantly expand the capacity of the private insurance and reinsurance sector to cover disaster losses in the context of an integrated CAT risk management strategy, but also because they may constitute innovative risk transfer tools for governments themselves.¹⁷

Purposes of this report

Against this background, this report intends to assess the potential role of capital markets in financing reconstruction and recovery from large-scale natural catastrophes, develop a better understanding of CAT-linked instruments – including the drivers and impediments to their further growth – and identify technical and policy issues relating to the future growth of CAT-linked securities markets. While it is predicted that in the long term these markets will continue to grow, the current financial crisis suggests the need for caution in the development of CAT-linked instruments and markets in light of possible transparency issues and investor protection concerns.

Structure of this report

The report is divided into five sections. Section two identifies the problem by describing the nature and costs of CAT risks and the ability of insurance and reinsurance to absorb and transfer these risks. This section investigates the role that capital markets might play in the direct transfer of CAT risks, whether as a substitute for, or complement of, insurance and reinsurance. The section also provides a framework for analysis by reviewing the growth of securitisation and identifying key drivers accounting for its growth. Section three provides an overview and analysis of CAT-linked securities and derivatives. The evolving structure of CAT-linked instruments, and the role of pricing and credit ratings, are considered in this section. Section four notes the key drivers of, impediments to and issues in the development of CAT-linked securities, using the framework for analysis developed in section two. The final section offers some recommendations.

2. Nature of the problem and potential role of capital markets as a solution: framework for analysis

2.1 Nature of natural catastrophe risks, their economic costs, and losses absorbed

Insurance markets provide the means for individuals and organisations to transfer the risks of loss to insurers who pool the pure risks and, via the law of large numbers, make the unit loss more certain and the distribution less risky. The law of large numbers relies, however, on the independence of risks in the pool. Some perils abrogate that independence despite reinsurance because the spatial correlation of risks diminishes the effectiveness of the insurer's geographic diversification. Reinsurance does allow the insurer to transfer risk to an entity with a more geographically diversified pool of risks, but reinsurance capacity is finite and any attempt at retrocession¹⁸ simply chases a diminishing capital capacity.

a) Existing system for the transfer of CAT risk

The property-liability insurance industry faces risks that may be characterised as high frequency, low severity and as low frequency, high severity. The high frequency, low severity risks in its books of business (e.g., automobile collision losses) may represent serious financial risks to the insured but are small risks to the insurer and industry. These risks can be characterised as independent, so that the law of large numbers applies; given a large number of independent risks, the law of large numbers shows that the average risk becomes fairly predictable. By pooling such risks in its books of business, insurers can charge premiums that reflect the average loss plus expenses plus a risk-bearing premium. The industry's equity capital may be expected to cover any adverse deviation in losses.

By contrast, the low frequency, high severity risks in its books of business (e.g., home owner's property loss due to a hurricane), while representing the same serious financial risks to the insured, also create large risks to the insurer and the industry. Such catastrophic risks are more difficult to manage. The low frequency makes predictability problematic and, given the occurrence of a CAT event, the risks in a book of business may be highly correlated. Hence, the law of large numbers, which makes pooling an effective management tool in the high frequency, low severity case, becomes ineffective and less appropriate in the low frequency, high severity case. The equity capital of the insurer and the industry may not be able to cover a large CAT risk.

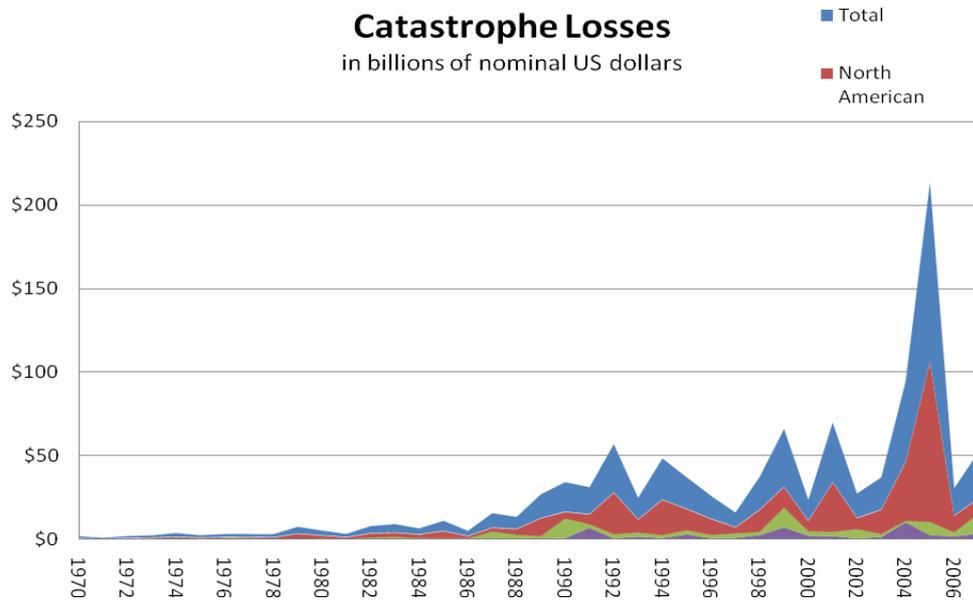
To gain an historical perspective, Figure 1 shows the dollar costs of the worldwide catastrophic risks both natural and man-made from 1970-2007. The North American losses are quite large; it is instructive to compare those insured losses with the capital capacity of the insurers.

¹⁸ Retrocession is the reinsurer's reinsurance; the retrocession transfers part of the reinsurer's risks to other reinsurers or insurers.

Figure 2 shows the historical development of U.S. policyholder surplus (PHS), which is a gross measure of the property-liability insurance industry’s ability to meet its obligations. It reached a local minimum in 2002 but has risen steadily since then to reach a half trillion US\$ in the third quarter of 2007.

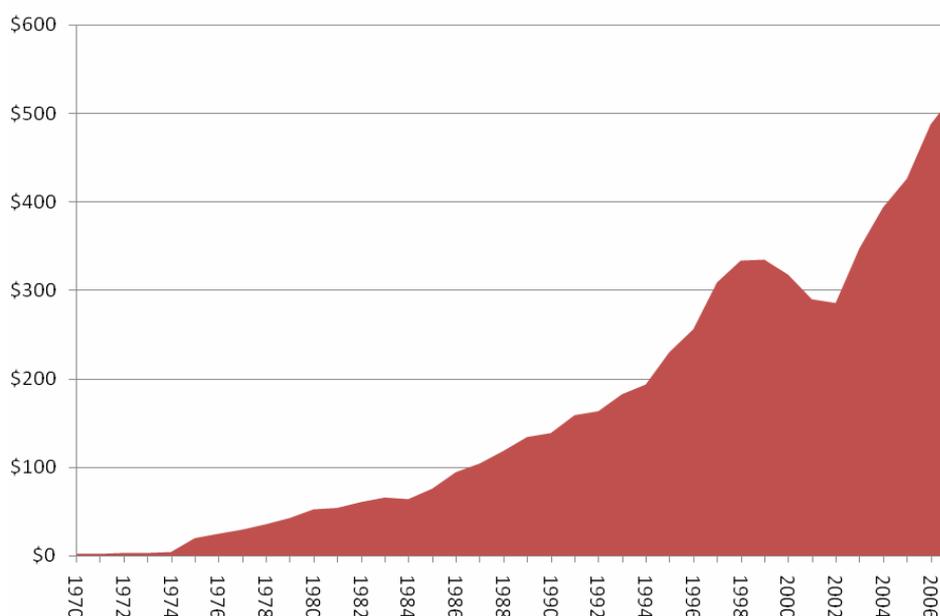
While the surplus is instructive, viewing CAT losses as a proportion of the surplus allows us to roughly gauge the ability of the U.S. insurance industry to absorb losses resulting from these large events. Figure 3 shows that the proportion of CAT losses has risen to 15 percent or above only twice in the last thirty years; the last time it did so was due to Hurricanes Katrina, Rita and Wilma in 2005.

Figure 1: World Natural and Man-Made Catastrophes (Source: Swiss Re, 2008)¹⁹



¹⁹ The total losses also include losses from Africa, Antarctic, Australia and Oceania, South America, worldwide and space.

Figure 2
U.S. Insurer Policyholder Surplus
in billions of nominal US dollars



Source: A.M. Best, ISO, Insurance Information Institute

While the last spike reached over one fifth of the surplus, a substantial portion was reinsured or covered by capital market instruments, i.e., 44 – 53 percent by reinsurers and 1 - 3 percent by capital markets.²⁰ The 44 to 53 percent would amount to a US\$20.7 to US\$24 billion dollar loss to reinsurers. If the loss were covered solely by U.S. reinsurers, then it would amount to between 30 and 35 percent of their surplus.²¹ While these numbers are rough approximations, they are large relative to the available U.S. reinsurer surplus.

b) Pricing and capacity dynamics

The reinsurance market is subject to cycles and reinsurance premia were rising before Hurricane Andrew in 1992. The further increase in reinsurance prices after Andrew is shown in Figure 4, which depicts the Guy Carpenter Reinsurance Rate Online (ROL) index from 1990 through 2007.²² The cycles of hard followed by soft reinsurance markets are well known but have not been adequately explained by

²⁰ See *Hurricane Katrina: Analysis of the Impact on the Insurance Industry*, Tillinghast, October 2005

²¹ This is based on an estimated US\$68 billion in U.S. reinsurer PHS in 2005. See *Property/Casualty Insurance Financial and Hurricane Update*, 2006, Insurance Information Institute.

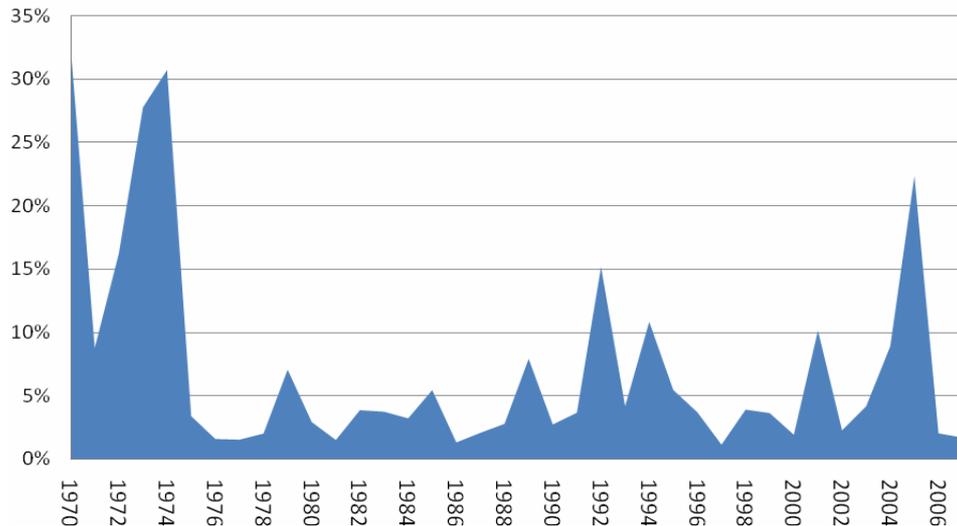
²² Reinsurance Rate Online (ROL) is defined as the premium divided by the indemnity.

²³ There have been notable explanations of cycles but none that are fully acceptable, e.g., see Cummins, J. D. and J. F. Outreville (1987). "An International Analysis of Underwriting Cycles in Property-Liability Insurance." *Journal of Risk and Insurance* 54(2): 246-62, Winter, R. A. (1994). "The Dynamics of Competitive Insurance Markets." *Journal of Financial Intermediation* 3(4): 379-415, Cummins, J. D. and P. M. Danzon (1997). "Price Shocks and Capital flows in Liability Insurance." *Journal of Financial Intermediation* 6: 3-38, Lai, G. C., R. C. Witt, et al. (2000). "Great (and not so Great) Expectations: An Endogenous Economic Explication of Insurance Cycles and Liability Crises." *Journal of Risk and Insurance* 67(4): 617-652.

insurance or financial market theory.²³

Figure 3

North American CAT Losses as a proportion of U.S. Insurer PHS

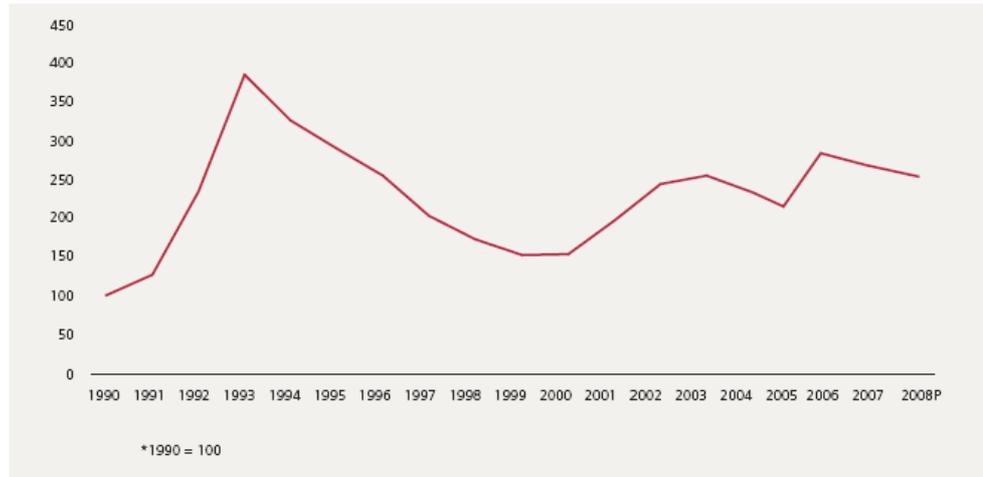


Source: Swiss Re, A.M. Best, ISO, Insurance Information Institute

c) Possible limitations of insurance markets: insurability of natural catastrophe risks and capacity of the insurance and reinsurance industry

Insurance and reinsurance markets are well suited to independent risks that can be pooled. Natural catastrophes generate highly correlated risks and therefore challenge the typical notion of an insurable risk. This has become increasingly important as the size of the CAT losses has risen so dramatically this century. The capital capacity of the insurance industry has increased as evidenced by Figure 2, but that increased capacity does not necessarily represent an efficient use of financial resources.

Figure 4: Guy Carpenter Reinsurance World ROL Index



Source: 2008 Reinsurance Market Review: Near Misses Call for Caution, Guy Carpenter, LLC, 2008

Transferring CAT risks to the capital market, however, does allow these risks to be divided and borne by investors at a price that should be appropriate for the risk bearing involved. In fact, financial market theory does quite clearly show that hedging risks in capital markets can reduce volatility and create value. Although the amount of CAT risk that has been transferred to the capital market is still quite small, Figure 4 suggests that it has dampened the cycle in the reinsurance markets. CAT-linked securities decrease the volatility of insurer or reinsurer earnings by providing capital when it is needed, i.e., when a catastrophe triggers a payout; these securities also provide multi-year coverage at a known premium and this may dampen the rise in premium in a hard market as well as the fall in premium in a soft market.

2.2 Stages of evolution of risk securitisation in capital markets: framework for analysis

Some lessons can be drawn from past experiences of securitisation of risk in capital markets – including the recent financial crisis – in order to assess the possible roles of capital market instruments in the transfer of catastrophe risks. Specifically, by reflecting on the conditions that contributed to the growth and liquidity of markets like the MBS and ABS markets, the credit derivatives market, and, to a lesser extent, the weather derivatives market, and understanding the reasons for the breakdown of securitised markets in 2007 and 2008, we can identify key drivers and impediments to the future development of the CAT-linked securities market. The following examination of past experience with securitisation (mostly pre-dating the financial crisis) provides a framework for analysis that will serve to facilitate our understanding of the growth and evolution of CAT-linked securities.

Securitisation dates back to the early 1970's when a U.S. government sponsored agency called the Government National Mortgage Association (Ginnie Mae) pooled mortgage loans and sold single-class MBS collateralised by that pool of loans. Other federal agencies, namely the Federal Home Loan Mortgage Corporation (Freddie Mac) and Federal National Mortgage Association (Fannie Mae), followed suit in the early eighties, but instead issued multiple classes of

securities against the pooled mortgages in order to access investors with various risk tolerances more efficiently. Financial institutions started issuing their own collateralised securities soon thereafter. Non-agency (private) MBS issuance surpassed agency MBS issuance for the first time in 2005²⁴.

Securitisation soon expanded to ABS and collateralised debt obligations (“CDO”). ABS typically refer to the securitisation of pools of homogeneous assets like account receivables. CDO, which appeared in the late eighties, are more complex instruments. They became – until the current financial crisis – a crucial component of securitisation in the mortgage and credit markets²⁵. Issues related to the opacity of CDO structures emerged in the course of the financial crisis.

Finally, securitisation of weather risk began in 1996 with an over-the-counter derivative contract between Aquila Energy and Consolidated Edison. The appearance of weather derivatives contracts just preceded the issue of CAT-linked securities such as CAT bonds. Weather derivatives were somewhat unique in securitisation markets in that they were usually not based on portfolios of pooled individual risk, but on indices of more independent measures of weather risk like indices of temperatures or snowfalls for a specific location.

a) Key drivers to initial market development

Historically, some common factors contributed to the initial development of securitised capital market instruments:

- ***Need for additional market capacity and need for transferring risk:*** Securitisation in the MBS market allowed banks to move loans off their balance sheets by selling them to outside investors. This technique enabled them to grant more loans and, in the process, transfer mortgage-related risks (interest risk, default risk and pre-payment risk) to risk-takers. The same motivation accounted for the securitisation of credit risk via credit derivatives and weather-related risks via weather derivatives and for CAT risks via insurance-linked securities. As mentioned, however, there are notable distinctions between the securitisation of *assets* and the securitisation of *liabilities*. Since the typical P&C portfolio consists of a wide spectrum of uncorrelated risks, creating diversification benefits, non-life insurers have limited incentives to transfer these risks to the market. Moreover, from a legal perspective, insurers cannot be removed from the risk equation since they must respond directly to their policyholders. Insurers, therefore, would be able to use ILS to obtain additional financial capacity,²⁶ but not to adopt an aggressive “originate

²⁴ FDIC Outlook, 2006.

²⁵ Broadly speaking, CDO can be defined as a pool of debt contracts housed within a special purpose entity (SPE) whose capital structure is sliced and resold to investors. “Cash flow” CDO are collateralised by a portfolio of outstanding debt issued by a range of companies, while “synthetic” CDO are not collateralised by actual bonds but by more complex credit arrangements like swaps. Examples of cash flows CDO are MBS or credit-linked notes. Examples of synthetic CDO are CDO collateralised with credit default swaps (“CDS”) or other types of credit derivatives.

²⁶ As acknowledged by the IAIS (*Issues paper on non-life insurance securitisation*, October 2003), securitisations can provide non-traditional sources of capital market financing, thus complementing and supplementing

and transfer” model similar to the one that characterised the sub-prime lending practice and related MBS market in the United States.

- ***Investor appetite for diversified risk:*** Hedge fund managers, money managers, and other institutional investors provide services to their clients in the form of portfolios of securities. These services require the selection of assets and construction of portfolios. Institutional investors view assets from the perspective of what they contribute to the portfolio; if an asset has an expected return as least as great as the existing portfolio and a return uncorrelated with the portfolio then received financial theory shows that such an asset should be included in the portfolio (Samuelson 1967). Uncorrelated assets allow institutional investors to diversify their asset portfolios. Hence, institutional investors seeking uncorrelated assets provided the demand for securitised risks.

Securitisation helps in the pooling of individually illiquid assets into portfolios and in the subdividing of these assets into classes of securities. This process allowed investors to participate in previously illiquid markets and helped them further diversify their asset portfolios.

- ***Development of methodologies for risk assessment:*** U.S. rating agencies like Standard & Poor, Moody’s and Fitch Ratings played an important role in the development of asset securitisation by developing methodologies to evaluate the risk embedded in securitised instruments. Securitisation is a complex procedure, so that investors rely heavily on risk ratings for the selection of securities in their portfolios. While U.S. ratings agencies have been under fire lately, allegedly for flawed ratings of mortgage CDO structures, their role remains crucial in securitisation. As discussed below, the role of credit rating agencies and catastrophe modelling firms in assessing the impact of a natural disaster on an insurer’s book of business has been invaluable to the CAT-linked security market.
- ***Government initiatives aimed at facilitating market growth:*** The MBS market, in particular, may not have expanded as quickly as it did if the U.S federal government and federal agencies had not contributed to its development at the outset. The role of Ginnie Mae, Freddie Mac, and Fannie Mae in mortgage-backed securities issuance, and in providing liquidity in the secondary market, was critical for the development of securitisation and remains crucial.

traditional debt and equity financing available to a business. For the insurance and reinsurance businesses, in particular, the securitisation concept has proven to provide an attractive alternative source of capacity, since CAT bond investors for the most part do not also provide traditional (re)insurance protection. See also: Swiss Re Sigma, *Securitization – New Opportunities for Insurers and Investors*, cit., pp. 3 ff.

- **Legislative and/or regulatory factors:** Elul²⁷ argues that legal factors and government regulation were also important drivers of securitisation. For instance:
 - Securitisation helped in lowering banks’ regulatory capital requirements. For instance, the demand for credit derivatives by banks was spurred largely by the 1988 Basel Accord, which mandated that large commercial banks maintain a minimum amount of surplus, based on the amount of (credit, operating and interest) risks in their balance sheet. The banks realised that they could transfer the credit risk of borrowers to entities not subject to bank capital requirements, while retaining at the same time the ownership and revenue from such loans.
 - Pension fund, mutual fund, and hedge fund regulations (or lack thereof) may explain the credit enhancement and tranching techniques embedded in some securitised products, which broadened their appeal. In the U.S., pension and mutual funds can be heavily regulated in their holdings of low-rated asset-backed securities, while hedge funds are lightly regulated in their investments. Security tranching into high-rated senior tranches and low-rated junior tranches helped in circumventing the regulatory framework applicable to pension funds and mutual funds. Hence, tranching expanded the breadth of the market by enabling the participation of additional institutional investors.

While the above mentioned factors certainly contribute to explaining the success of securitisation in the recent past, regulatory arbitrage should not be encouraged and, to the contrary, it may lead to undesired outcomes, as witnessed by recent events in the CDS market²⁸.

b) Market evolution

While the securitisation of mortgage, credit, and weather risk is currently experiencing difficulties in light of the financial crisis, the evolution of this market in recent years and its features are worth noting as a point of reference:

- **Increased complexity in design of capital structures:** Increased complexity could be observed in the design of capital structures. For instance, the securitised mortgage market evolved from simple pass-through securities to CMO to CDO. In the credit markets, cash and synthetic CDO issuance surpassed the size of the CDS market. This complexity largely stemmed from the introduction of new types of collateral in the underlying pools” of assets. This led to less homogeneity in the underlying collateral and possibly made the pricing of these

²⁷ Elul (2005).

²⁸ As opposed to regulated financial guaranty and credit insurance undertakings, protection sellers under a CDS are generally not required to set aside technical reserves commensurate to the risks undertaken. Moreover, CDS protection sellers can offer certain contract terms that, in several jurisdictions, cannot be legally included in policies issued directly by a financial guaranty insurer (e.g., broader definitions of “credit event”, acceleration of payments provisions). See State Of New York, Insurance Department, Circular Letter No. 19 (2008), September 22 , 2008, available at http://www.ins.state.ny.us/circltr/2008/cl08_19.htm

securities more difficult.

- ***Refinement of risk-return profiles:*** The tranching of securities into highly rated senior debt and low-rated junior debt helped to refine the risk-return profiles of CDO and attract a larger base of investors. Banks, pension funds, and insurance companies were likely to invest in AAA-rated securities in the senior securitised tranches, while hedge funds and other specialised funds could focus more on the equity portion of a CDO and on lower-rated tranches.
- ***Further advances in technology and modelling:*** Advances in technology and modelling - cash flow modelling, data processing, and data availability - contributed to public acceptance of securitised products and will continue to play an integral role in innovation in markets for securitisation. Market participants can now model more accurately the timing and amount of irregular cash flows (such as late payments, defaults, recoveries, prepayments) from an underlying asset pool in a securitisation deal. Data vendors like Bloomberg or Reuters even post their proprietary pricing models on their terminals for use by investors.
- ***Growth of index-based securitised instruments:*** The proliferation of index-based securitised instruments likely contributed to increased liquidity and trading of securitised instruments prior to the crisis. This development was notable in credit markets; CDS on indices surpassed CDS on single names as the dominant product type.²⁹ Research has shown³⁰ that the issuance and trading of index-based products grew rapidly due to the increased acceptance of indexes such as, for instance, the Dow Jones iTraxx credit indexes. These indexes are subject to transparent rules and helped to standardise CDS structures. Moreover, since 2004 dealers in credit markets has promoted liquidity in the trading of index-based CDS. Such measures included the development of master confirmation agreements³¹ and commitments to make markets with tight bid-offer spreads

c) Conditions for market growth and liquidity in securitised markets

Based on this description of securitisation, the conditions for market growth and liquidity in securitised markets can be identified (beyond the basic driving factors of demand for securitised risks on the part of investors and hedgers, and the desire on the part of originators and other parties to transfer these risks):

i. Organised regulatory framework, government support, and conducive regulatory and tax environment

²⁹ British Bankers Association (2006).

³⁰ Mengle (2007).

³¹ A master confirmation agreement is "...a contract in which all the terms that have to be agreed to only once by the parties are established for a single product group (such as European/North American single credit default swaps). That allows only the terms that change with every trade, called the transaction supplement or "short form," to be automated and confirmed".

(see <http://www.dtcc.com/news/newsletters/dtcc/2006/jan/master.php>).

Securitised markets function better and gain public acceptance if they operate under an organised regulatory framework, provided either by government supervision or by self-regulation, that is aimed at protecting market participants and fostering efficiency. For instance, in the credit derivatives markets, the ISDA, the self-regulatory arm of swap dealers, routinely helps to settle trade disputes and counterparty default issues. Exchange-traded derivative instruments, like the CME weather derivatives or the credit index event contracts, benefit from the management of default and recovery by the exchanges' clearing corporations.

In addition, government participation in, and backing of, securitised markets provide a major stimulus. For instance, the U.S. federal government greatly facilitated the development of the mortgage securitised market by backing issuance of Ginnie Mae mortgage-backed securities. And, while Fannie Mae and Freddie Mac securities were not explicitly backed by the full credit and faith of the U.S. government, U.S. regulators ultimately would not let these institutions fail in the event of financial problems, as demonstrated by recent developments in which the U.S. Treasury has publicly indicated the need to sustain the solvency of these mortgage institutions and has injected capital to support these institutions.

A conducive legal and tax environment also favours securitisation, as demonstrated by the U.S. experience. For instance, in the mortgage market, CMO issues first faced complex tax, accounting and regulatory obstacles. The U.S. tax reform act of 1986 included the Real Estate Mortgage Investment Conduit tax vehicle that solved most of these legal issues.

ii. Organised market frameworks and infrastructures

Securitised markets also function better and gain public acceptance if they operate under an organised market framework and well-functioning market infrastructures. For instance, the credit derivative markets benefited from such collective actions. The rapid growth of CDS outpaced the development of infrastructure necessary to clear and settle these transactions. Post-trade processes were largely manual and by early 2005, credit derivatives dealers had huge backlogs of unconfirmed trades. Dealers and asset managers moved to adopt an electronic confirmation service; as a result, the number of CDS confirmations outstanding thirty days or more declined significantly³². In light of the crisis, governmental authorities have proposed the establishment of a comprehensive institutional framework for over-the-counter ("OTC") derivatives (including CDS), including requiring standardised contracts to trade through regulated central counterparty clearing houses³³, in order to minimise systemic risks.

iii. Standardisation

Standardisation enhances market liquidity and helps investors manage their portfolios more efficiently. Credit derivatives, for instance, are characterised by a higher degree of standardisation than other types of OTC derivatives. Market participants have widely used the relatively standardised ISDA Credit Swap Master Agreement as a blueprint for credit derivatives transactions. The

³² Kroszner (2007).

³³ See, for instance, U.S. Treasury press release of 13 May 2009 outlining U.S. proposals in this area ("Regulatory Reform Over-The-Counter (OTC) Derivatives"). See www.treasury.gov

standardisation of such agreements decreases the costs of initiating and trading credit default swaps.

As noted above, transactions in index-based CDS attracted considerable interest. Their ‘popularity’ stemmed from the fact that they provided, by means of indices, investors with new tools for taking on, hedging, and managing credit risk in their portfolios, thus contributing to greater market liquidity.

Finally, the growth of the weather derivatives market in recent years can be attributed almost exclusively due to increased trading volume in OTC index-based derivatives and in index-based futures and options contracts at the CMEX.

iv. Market transparency

Market transparency also enhances market liquidity. Transparency in some securitised markets (MBS and CDS) improved in the course of their development, and particularly in recent years, while some other markets (e.g., CDO) remained opaque, as witnessed by the current financial crisis.

In the U.S., the mortgage-backed security market has benefited from a regulatory change that took effect in 2002 and which enhanced transparency. Security dealers must now report almost all corporate bond trades to the National Association of Securities dealers (NASD) within 15 minutes; the NASD then immediately reports the trade to the market via data vendors like Bloomberg or Reuters.

The prices of many credit derivatives, including single-names or index-based CDS and credit index tranches, are also widely reported to services like Bloomberg and Reuters. On the other hand, more complex credit derivatives like CDO tranches remain largely illiquid and opaque.

v. Diversification of market participants

Diversification of market participants is a key driver to market growth. This point is well supported in the credit derivatives market.

A British Bankers Association report (2006) on credit derivatives shed some light on the diversity of participation in this market. In 2000, banks and securities firms were dominant in 2000 and represented over 80 percent of credit protection buyers and 60 percent of credit protection sellers. By 2006, their participation had declined to about 60 percent of buyers and 44 percent of sellers. Recent new participants in the market included insurance companies, which tend to be active sellers of credit protection, and hedge funds, which tend to function as both buyers and sellers of credit protection. In 2000, hedge funds represented 3 percent of buyers and 5 percent of sellers, but in 2006, they had grown to 28 percent of buyers and 32 percent of sellers. Pension fund and mutual fund participation in credit derivatives remains at 1-2 percent as buyers and 2-4 percent as sellers.

It is important to note that, for the most part, the complexity of securitised structures in all markets made them suitable investments only for investors with knowledge of complex financial transactions, notably institutional investors who actively manage credit or mortgage portfolios. These investors typically have access to sophisticated analytical tools unavailable to individual investors. This

explains why only qualified institutional investors are active (and are permitted by regulation to be active) in most securitised markets.

d) Impediments

Asymmetry of information among participants in securitised markets, combined with heterogeneity of pooled risks, may be an impediment to market growth, as demonstrated by the recent crisis in particular. Securitisation of risk becomes more successful when the capital structure provides an equal playing field in terms of information between risk transferors and risk takers. However, asymmetry of information combined with heterogeneous pools of risks may prevent risk takers from confidently assessing and pricing the underlying risk in various securitised structures, and may either deter some of them from participating in these markets or cause them to take flight at the first hint of trouble in a securitised structure, as demonstrated by the financial crisis.

Asymmetry of information often leads to adverse selection and moral hazard. In the context of securitisation, adverse selection refers to the fact that, without a full ability to monitor a risk transferor's portfolio of risks, the risk transferor may securitise the most unattractive part of its portfolio. Moral hazard arises when the entity that transfers individual risks or a portfolio of risks no longer has the incentive to reduce risk.

Some index-based capital market structures may alleviate asymmetry of information problems as long as the components of the index are not subject to possible manipulation. A good example of a non-manipulable index can be found in the weather derivative market. Most weather derivatives are based on an index of heating degree days (HDD) or cooling degree days (CDD), which are provided by an independent entity, the U.S. National Weather Service. In the credit market, Dow Jones is an independent firm that calculates and monitors both the CDX index (consisting of the risk of 125 North American investment grade firms) and the iTraxx index (consisting of the risk of 125 Euro-based investment grade firms).

In MBS and ABS markets, deal structures tend to bundle homogeneous pools of assets such as mortgages or receivables with similar characteristics and generally idiosyncratic risk³⁴ is well diversified within the pool. Consequently, diversified and homogeneous pools of assets can be valued based on default probabilities that draw on the historical performance of similar asset pools³⁵.

In contrast, in credit markets, some complex CDO structures could be collateralised by a relatively heterogeneous pool of risks, such as different types of bank loans, corporate debt, different types of derivative instruments, or even other CDO. Both systematic³⁶ and idiosyncratic risks remain important in the pool performance and valuing these pools on the basis of historical default probabilities may be inadequate because of the idiosyncratic risks remaining in

³⁴ Idiosyncratic or nonsystematic risk is that risk which is inherent in a company or industry; it is also often called diversifiable risk.

³⁵ FDIC (2006).

³⁶ Systematic risk is that risk which is inherent in the market; it is also often called market or non-diversifiable risk.

the pool.

The CDO market moved toward more sophisticated valuation models, but these models were accessible only to “extremely sophisticated” institutional investors. The recent losses borne by large investment banks in complex CDOs backed by pools of sub-prime mortgage and credit risks show that even sophisticated investors are not immune from this problem.

2.3 Possible roles of capital markets and capital market instruments in the transfer of CAT risks

CAT risks are large relative to the capital capacity of reinsurers, and insurers have historically transferred a significant proportion of their property risk to reinsurers, including their CAT risk. Bob Hartwig³⁷, President of the Insurance Information Institute, has noted that global reinsurers absorbed 20 percent of the four 2004 hurricane losses and 45 percent of the 2005 hurricane losses – which were themselves more than twice the cost of the 2004 storms. As coverage in high-risk areas increases, the capital capacity of reinsurers becomes more limited and generates the need for either higher limits on instruments such as excess of loss reinsurance or additional capital capacity at the right price. CAT-linked securities provide a means of managing this risk by transforming pure risks into speculative risks and then transferring these speculative risks to capital markets, which have a potentially huge capacity to absorb catastrophe risks.

a) Complement or substitute to reinsurance

Excess of loss reinsurance or retrocession is often written in layers. The lower layers are associated with greater historical frequencies and thus are more predictable than the higher layers. This system allows insurers and reinsurers to select coverage and to separate the higher frequency lower severity from the lower frequency higher severity; equivalently, the excess of loss coverage allows insurers and reinsurers to separate extreme CAT risks from other risks. The lower layers consist of those risks that can be expected to be effectively and efficiently pooled, and rely both on the law of large numbers and better diversification. The higher layers constitute the CAT risks where predictability is more of a problem.

In the higher layers, there is some reason to view reinsurance or retrocession and CAT-linked securities as *substitutes* if the capital capacity of the insurer or reinsurer is sufficient to eliminate its credit risk. The pricing of each type of instrument should determine whether reinsurance or CAT-linked securities dominate the market, even if cost comparison is not straightforward³⁸. As the credit risk of reinsurers is strained by additional coverage of the higher layers, however, there is more reason to view the instruments as *complements*. Additional reinsurance requires more capacity and one way to achieve that capacity is via CAT-linked securities. There are, of course, other ways to create additional capacity, such as through IPOs and sidecars. New reinsurers entered

³⁷ See presentation by Robert Hartwig to the Institute for Building and Home Safety in Orlando, Florida on November 17, 2006, on file with authors.

³⁸ See below, section 4.3 a).

the market and new sidecars were developed in the aftermath of Katrina.

In any case, the ability to tap both reinsurance and capital markets is crucial to ensure access to capacity in distressed times.

b) Potential size of demand

Until the recent financial crisis, the demand for CAT-linked securities had been growing with the size of the CAT losses. Evidence has already been provided on the dramatic increases in the worldwide CAT losses as well as the U.S. CAT losses in the past decade. The CAT bond market also gained speed. Between 1997 and 2006, there were only 89 transactions for a total of US\$15.35 billion issued. In 2007, US \$13.8 billion of CAT risk was securitised in the form of bond issues, compared with US\$8.5 billion in 2006. As mentioned, however, the market slowed down in 2008, partly because of the credit crisis. New CAT bonds featuring improved structures and tighter collateral requirements were issued in 2009, but prices have also increased substantially.

Both insurers, reinsurers and other actors such as governments may, for a number of reasons outlined below, wish to make use of CAT-linked securities – such as CAT bonds and CAT-linked derivatives – for risk transfer purposes. For investors, there may a significant, longer-term demand for CAT-linked securities such as CAT bonds given their potential benefits for portfolio diversification.

3. Overview and analysis of CAT-linked securities

3.1 Overview of CAT-linked securities

The following provides a brief description of some of the CAT-linked securities that have been issued or traded in capital markets:

a) CAT bonds

A CAT bond is a high-yield bond that contains a provision that may cause the principal or interest payments to be delayed or lost to investors in the event of a specified loss such as a hurricane or earthquake. The CAT bond provides the insurer with fully collateralised multi-year cover for well-defined risks on an excess of loss basis.

The sponsor (i.e. the risk bearing entity that wishes to transfer CAT risks to capital markets), creates a special purpose vehicle (SPV). The purpose of the SPV is to provide loss protection to the sponsor. The sponsor pays a premium to the SPV that issues bonds to qualified institutional investors and uses the proceeds of the sale plus the premium to purchase highly rated short-term investments such as Treasury notes. The SPV also enters into an interest rate swap to convert the periodic investment income from the short term investments to LIBOR, makes the periodic coupon payments to investors, and ultimately repays the principal upon maturity unless a loss occurs before maturity that triggers loss payments to the sponsor. See Annex 1 for the structure of a CAT bond. As mentioned, the collateralisation provisions of CAT bond structures have been tightened in 2009: most recent deals impose strict prudential rules on how the collateral is invested, feature daily mark-to-market accounting on the collateral accounts and “top up” requirements in the event that asset values fall below par. These new structures also feature improved transparency and easier access to information on the underlying assets,

as well as contractual mechanics to facilitate the replacement of the swap counterparty or to unwind the transaction in case of default, with a view to better protecting the interests of investor and sponsor

b) Catastrophe collateralised risk obligations (CROs)

In a CRO, an SPV managed by a risk manager assembles a portfolio of risks consisting of traditional reinsurance and CAT-linked securities. The SPV then issues multiple tranches of notes and a tranche of equity that successively attach upon exhaustion of the previous layer. CRO offerings, like CAT bonds, are fully collateralised³⁹. Investors in a CRO immediately benefit from portfolio diversification in insurance risk.

c) CAT-linked derivatives

While the first attempt to launch exchange-traded CAT-linked futures and options failed due to lack of attention and low liquidity, there have recently been attempts to revive a derivatives market. Over-the-counter instruments such as the Deutsche bank-sponsored event loss swaps or the NYMEX, the CME, and the IFEX exchange-traded futures and/or options contracts are examples of more recent innovations in CAT-linked derivatives. Below is a brief description of these products.

i. Event loss swaps

Although there is little publicly available information on OTC CAT-linked derivatives, we note that Deutsche Bank has recently begun to make two-way markets in what it calls event loss swaps. The Deutsche Bank event loss swaps, in their current form, work like credit default swaps. The buyer of event loss protection pays an upfront premium to the seller of the protection who must then pay the full notional value of the swap contract if industry-wide insurance losses breach a pre-agreed upon trigger. Features of the Deutsche Bank swap transactions are as follows:

- The swap contracts cover a one-year risk period and are sold in notional US\$5 million amounts, with the buyer upfront premium being expressed as a percent of the notional amount.
- The swaps contracts cover windstorm and earthquakes risks in the U.S. with thresholds levels sets at US\$20 billion, US\$30 billion, and US\$50 billion for hurricanes and tornadoes, and at US\$10 billion and US\$15 billion for earthquakes.

ii. NYMEX CAT risk index futures and options

The NYMEX contracts are standardised futures and options contracts co-developed by NYMEX and Gallagher Re (now Aon Re). The contracts settle against indices of industry losses estimated by the Property Claims Services (“PCS”). The indices are computed and maintained by Gallagher Re. NYMEX offers the futures contracts in the open-outcry and the options contracts on the GLOBEX electronic venue. The NYMEX clearing corporation also offers clearing services for index-based options traded off-exchange.

³⁹ An example of a CRO is Gamut Re that had a US\$310 million bond offering in May 2007. Goldman Sachs was the lead underwriter of the offering. Nephila, a private equity CAT fund assembled the portfolio of risks that includes traditional reinsurance, ILW, and CAT bonds.

Standard features of the NYMEX contracts are as follows:

- The futures and options contract prices are based on market (preliminary and subsequent) estimates of cumulative industry losses for catastrophes that occur during a calendar year. The contracts settle in cash at the end of March of the following calendar year.
- The Re-Ex index contains estimated losses from all perils identified by PCS except earthquake and terrorism.
- The Re-Ex index value is computed as the sum of cumulative industry loss estimates divided by US\$10 million. For instance, cumulative loss estimates of \$25 billion translate into a 2,500 point index. One index point is worth US\$10.
- NYMEX currently offers futures and options contracts on three regions: National, Florida, Maine to Texas (excluding Florida).

iii. CME hurricane futures and options

In many ways, the NYMEX contract design mirrors that of the CBOT now-defunct instruments. The CME, on the other hand, adopted a radically different approach in the design of its hurricane futures and options. First, the CME products are one-peril instruments. Second, they settle against the Carvill Hurricane Index (“CHI”), which is based on the parametric features of a hurricane, such as maximum wind velocity and size (radius). Third, the CME futures and options expire as soon as an official hurricane makes landfall. The contracts settle in cash against the value of the CHI, which is immediately released after the hurricane landfall.

Other features are as follows:

- The CHI is expressed in points. One index point is worth US\$1,000.
- CME currently offers futures and options contracts on five regions: Gulf Coast, Florida, Southern Atlantic, Northern Atlantic, and Eastern.
- The CME recently expanded its range of contracts to include seasonal aggregated futures contracts and options with a binary payout, i.e., either no payout or a full face value payout.

iv. IFEX event-linked futures

IFEX is a subsidiary of the Climate Exchange plc. Group and operates via the Chicago Climate Futures Exchange trading platform. The IFEX launched event-linked futures (ELF) contracts linked to U.S. tropical wind in September 2007 and will soon offer ELF contracts on other catastrophe zones and perils. The futures contracts are designed to mimic industry loss warranties with a payout linked to “first event” of the year, “second event” of the year, and so on. The futures contracts settle against an industry wind loss as estimated by PCS and offer a binary payout of US\$10,000 (when the industry loss amount reported by PCS equals or exceeds one of the applicable loss trigger levels) or zero. The applicable loss triggers levels for each listed event are currently US\$10 billion to US\$50 billion, in increments of US\$10 billion.

d) Other instruments

i. Industry loss warrants

An industry loss warrant (“ILW”) is an index-based instrument that can be structured either as an indemnity-based reinsurance contract or as a derivative contract. An ILW

may be considered a reinsurance contract when: (a) the contract buyer suffers a loss; and (b) the industry suffers a loss over a specified threshold. However, it is generally viewed as a derivative contract when it is triggered only by an industry loss. A.M. Best⁴⁰ has recently drawn analogies between the basis risk associated with non-indemnity triggered CAT bonds with that of ILWs.

ii. Sidecars

A sidecar is a reinsurance company that is created and funded by investors, such as hedge funds, to provide capacity to a single insurer or reinsurer (commonly called the sponsor) for its catastrophic losses. While CAT bonds allow insurers to transfer their property risk to the capital markets, sidecars are best described as tools that help insurers in financing any risk on their books, including property risks.

The structure of the sidecar is a reinsurance company created to provide quota share reinsurance protection to the sponsor via a quota share reinsurance agreement. The sidecar assumes a percentage of the sponsor's catastrophe risk in return for a percentage of the premium. The sidecar pays a ceding commission to the sponsor; the size of that commission increases in proportion to expected profitability. The sidecar accepts premiums and pays claims as a normal reinsurer. It also distributes interest and dividends to its shareholders. The sidecar usually has a lifespan of one or two years. See Annex 2 for a diagram outlining the structure of the sidecar.⁴¹

3.2 Market trends and analysis of the main features of CAT-linked securities

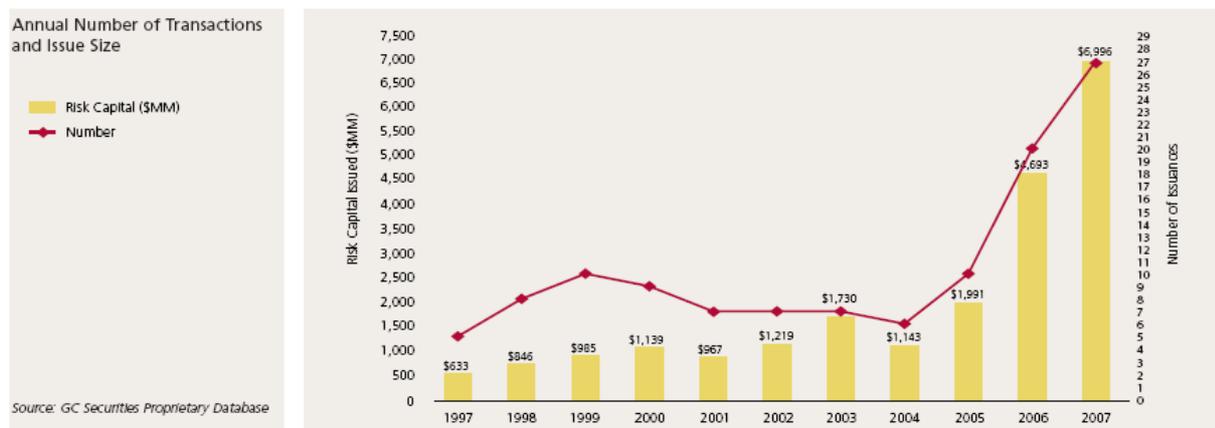
a) Size and growth of the market

One of the most important measures of market size is the total risk capital outstanding; that measure showed record growth in 2007. At year-end, there was more than US\$13.8 billion in outstanding principal and that represented a 63 percent increase over year-end 2006 which had also been a record. The annual issuance totalled almost US\$7 billion in 2007, which was 49 percent greater than the issuance in 2006 of US\$4.69 billion and 251 percent more than the issuance in 2005 of US\$1.99 billion. The number of transactions also set records in the last three years. The transactions are summarised in Figure 5.

⁴⁰ See A.M. Best's Press Release: "A.M. Best formally harmonises the basis risk evaluation of CAT bonds and ILWs", April 8, 2008.

⁴¹ As sidecars are not, strictly speaking, capital market securities, they will not, for the purposes of this report, be explored further.

Figure 5: CAT Bond Transaction History

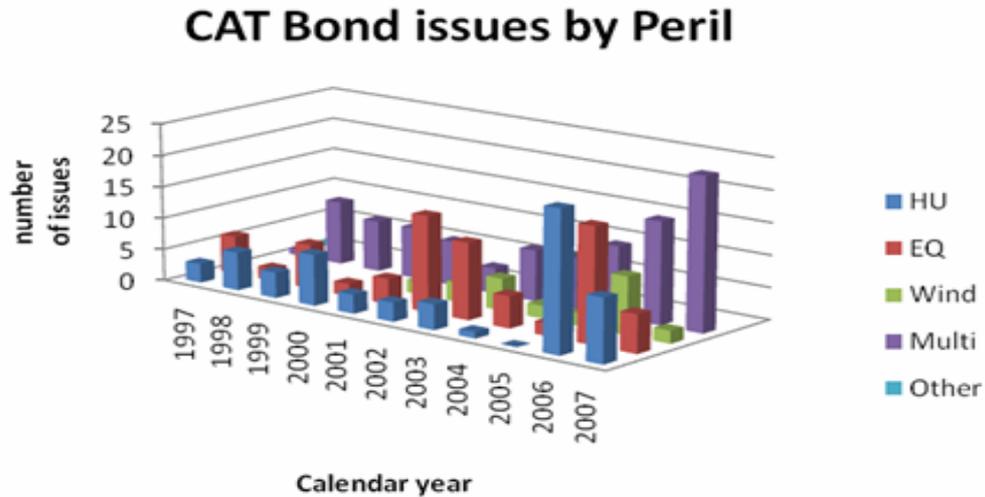


After this record-setting year, in 2008 CAT bond issuances fell 62 percent by volume (US\$2.7 billion in new and renewal capacity) and 52 percent by transaction count (13), with the vast majority of transactions taking place in the first two quarters. Towards the end of the year, planned CAT bond transactions were postponed partly because of the impact of the global financial crisis on secondary market spreads, and partly because of concerns over the effectiveness of the collateral protection mechanics embedded in CAT bond structures. The enhanced capacity and favourable rates in the traditional reinsurance market also contributed to this trend. In consideration of the above, as well as of the fact that that US\$4.7 billion in risk capital disappeared as 24 CAT bonds were redeemed according to their contractual terms, at the end of 2008 the total amount of outstanding CAT bond risk capital dropped to US\$11.8 billion, a 14.5 percent decrease from 2007.⁴²

Figure 6 provides a historical sketch of CAT bond issues by peril. The multi-peril bond issues include combinations of the perils such as U.S. hurricane, California earthquake and European wind or U.S. earthquake, U.S. hurricane and Japanese earthquake and, in rare cases, property, launch, aviation and marine. Hurricane, earthquake, and wind are the perils most often covered by CAT-linked instruments, whether individually or in multi-peril instruments. Indeed, the multi-peril CAT bonds have the most stable issuance history. These are perils for which more data exist, at least in North America, Europe and Japan; these are also perils that quite clearly violate the law of large numbers, making insurance coverage more difficult.

⁴² See GC Securities, *Cat Bonds Persevere in Tumultuous Market*, cit.

Figure 6



Source: Goldman Sachs

b) Triggers

The trigger on CAT-linked securities determines the conditions under which payments are made to the sponsor. The generic trigger types are as follows:

- **Indemnity:** The payouts depend on the sponsor's actual losses.
 - Advantage - This trigger eliminates basis risk.⁴³
 - Disadvantages - This trigger requires costly disclosure by the sponsor, requires more detailed risk analysis by the modelling firm, and has a long recovery period for investors (of up to 18 months, due to the need for the sponsor to calculate loss claims), thus offering less liquidity for investors; this trigger may also introduce a moral hazard problem (see *below*), to the detriment of investors.
- **Index:** The payouts are triggered by the industry loss estimated by an agency that collates such information for CAT events.
 - Advantages - This trigger yields a more transparent process, protects insurer privacy, and eliminates the moral hazard problem.
 - Disadvantages - This trigger yields basis risk and a possible mark-to-market problem if the CAT-linked instrument is treated as a financial derivative as opposed to a reinsurance contract, as volatility may be introduced into the balance sheet and earnings.
- **Parametric:** The payouts are determined by well-defined parameters of a CAT event. Parametric structures have themselves evolved through two generations. First-generation parametric triggers were based on the broad parameters of the event – such as the magnitude and location of an earthquake (located within a defined area) or the intensity of a hurricane at landfall. Second-generation triggers achieve a much better match with the actual loss by employing multiple

⁴³ Basis risk is the risk that the payoff on the catastrophe linked security will not match the sponsor's actual loss; such a difference can occur if, for example, the payoff on the CAT-linked security is determined as the average loss in the industry rather than the actual loss of the sponsor.

windspeed recorders or earthquake strong motion recorders and weighting the values at each recording site into an index tuned to match the distribution of actual losses.

- Advantages - This trigger also yields a more transparent process and a possibly more rapid verification process as well, allowing a transaction to be settled quickly (in weeks) after an event.
- Disadvantages – Basis risk and mark-to-market risk, although these are significantly reduced in second-generation triggers.
- **Model:** The payouts are triggered by a model industry loss that is determined by running the parameters of the actual event through a modelling firm’s database of industry exposures.
 - Advantages - This trigger may yield a rapid verification process. It also protects the privacy of the insurer.
 - Disadvantages - This process may be quite opaque, and yields basis risk and mark-to-market risk.
- **Hybrid:** The payouts are determined by a combination of two or more existing trigger types.
 - Advantages - This approach allows different triggers for different perils, or combinations of triggers, in order to reduce basis risk.
 - Disadvantages - The use of more triggers makes the process less transparent and more costly. Basis risk may remain as well as the mark-to-market risk.

The indemnity trigger has been the dominant form for CAT bonds because the payouts replicate reinsurance protection; use of this trigger was on the decrease with an exception and reversal in 2007. The indemnity trigger requires the disclosure of details about the covered portfolio that make it more costly both to the insurer that would prefer to not to reveal the information and the investor who must digest the information. This trigger also generates a possible conflict of interest since the insurer may settle catastrophic claims in a way that is disadvantageous to investors; this is the well-known moral hazard problem.

The index, parametric, model, and hybrid triggers remove the moral hazard problem from consideration but may leave a basis risk problem. The random difference between the CAT-linked security payout and the insurer’s loss represents the basis risk, e.g., for an index trigger, it is the difference between the estimated industry loss and the insurer’s loss. See Figures 7a and b for an historical sketch of trigger use. Both Figures 7a and 7b show more use of the indemnity trigger in 2007 than had been the case in earlier years

⁴⁴

⁴⁴ Note, however, that, in 2007, the State Farm US\$1.1 billion Merna offering accounted for almost half of the year’s indemnity trigger offerings. Without it, indemnity-triggered structures amounted to only US\$1.2 billion, compared to US\$1.8 billion for PCS industry loss triggered securities. The trade-off between basis risk and moral hazard is discussed in greater detail below in section 4.3 b).

Figure 7a: Proportion of issue value (in US\$ millions) by year and trigger type

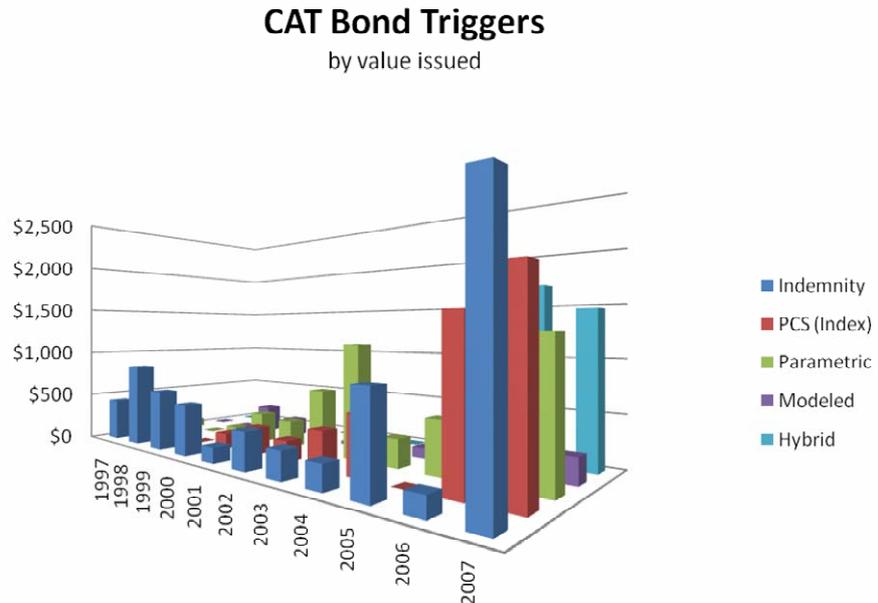


Figure generated from data in *The Catastrophe Bond Market at Year-End 2007*, Guy Carpenter & Company, LLC, 2008

c) Development of catastrophe loss models

Probabilistic catastrophe loss models have been crucial to the development of the CAT-linked securities market. The development of the CAT bond market was assisted by the general development and acceptance of second-generation catastrophe models that were first developed in the early 1990's and which became more generally accepted across the insurance and reinsurance industry by 1997 and in particular had become accepted by A.M. Best for the assessment of capital adequacy requirements. There were three principal catastrophe modelling companies working in this area in the mid-1990's: Risk Management Solutions (RMS), Applied Insurance Research (AIR), and EQECAT, a situation that remains unchanged today. The first CAT models were developed for U.S. earthquake and hurricane and the expansion of the countries and perils securitised reflects the expansion and maturity of the models themselves to other territories and the acceptance of these models as being sufficiently mature as to be used for risk transfer. Inevitably, acceptance of the models for structuring and pricing reinsurance risk transfer, as a standard procedure within the insurance industry, has preceded the use of the same models for transferring risk to the capital markets.

Figure 7b: Number of issues by date and trigger type

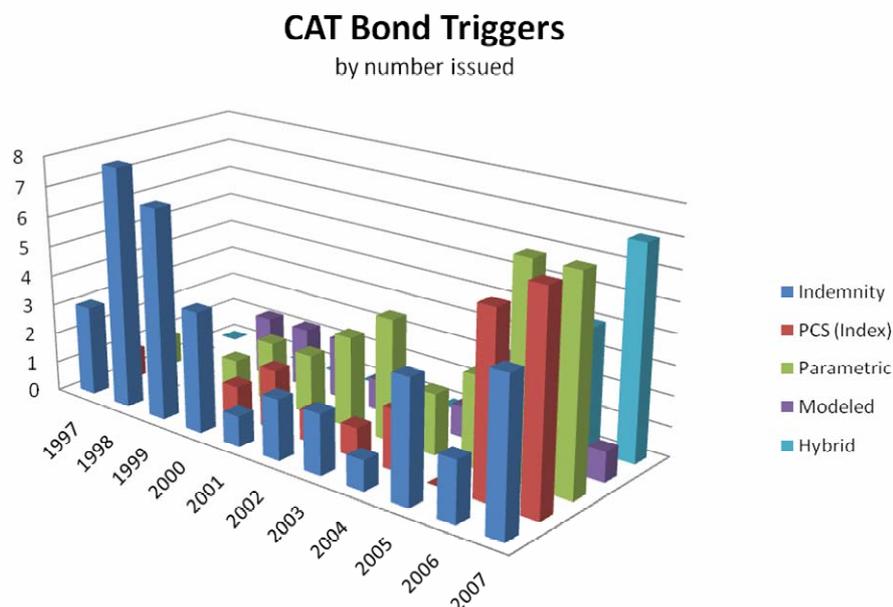


Figure generated from data in *The Catastrophe Bond Market at Year-End 2007*, Guy Carpenter & Company, LLC, 2008

d) Credit ratings of CAT-linked bonds

U.S. credit rating agencies have also had an important role in the development of the CAT-linked securities market. Credit rating agencies rely on stochastic modelling undertaken by the CAT risk modelling companies to derive estimated loss statistics. Their rating methodology of CAT-linked securities typically focuses on the following factors:

- Analysis of the issuer's insurance risk:** Credit ratings agencies rely on the input provided by catastrophe modelling firms in the form of a loss exceedance curve⁴⁵ that plots the bond issuer's loss against the probability of loss⁴⁶. The credit rating agency may then ask that the model is stress-tested with different scenarios and assumptions. The trigger (or attachment point), once validated by the rating agency, is then applied to the exceedance curve to determine the probability of loss at the trigger point.
- Evaluation of default risk:** Credit rating agencies compare the probability of catastrophic losses with the probability of default of corporate bonds estimated from historical data on corporate bond defaults, typically taking the probability of default from the loss exceedance curve and placing it in the relevant band. Figures 8a and b show the CAT bond ratings by issue value and year and by number and year, respectively. The figures show that the B and BB dominate in value and size historically. Only in 2007 did more highly rated CAT bonds reappear.

⁴⁵ The exceedance curve provides the probability of a loss of a certain size could occur this year.

⁴⁶ Catastrophe modelling firms construct a loss exceedance curve by simulating thousands of hypothetical catastrophic event scenarios with varied geographical locations and event characteristics. The scenarios are then applied against the portion of the cedent's book of business covered by the bond.

- **Terms and structure of the CAT bond transaction:** This includes the credit quality of the collateral placed in the SPV trust and the credit rating quality of the counterparty to the swap engineered by the SPV.⁴⁷
- **Risk of the CAT-linked security sponsor:** This includes the sponsor’s financial strength, length of time in business, history of sponsoring CAT-linked securities, management quality and other considerations.

Some CAT bond issues have been BBB-rated; however, the dominance of BB and B issues has grown so that the non-investment grade plays a prominent role in the market both in terms of relative value and numbers. See Figures 9a and 9b for a historical sketch of CAT bond issues by credit rating. There was a return to AAA and other investment grade CAT bonds in 2007 due to more tranches in the issues that year.

Figure 9a: Proportion of issue value by year and rating

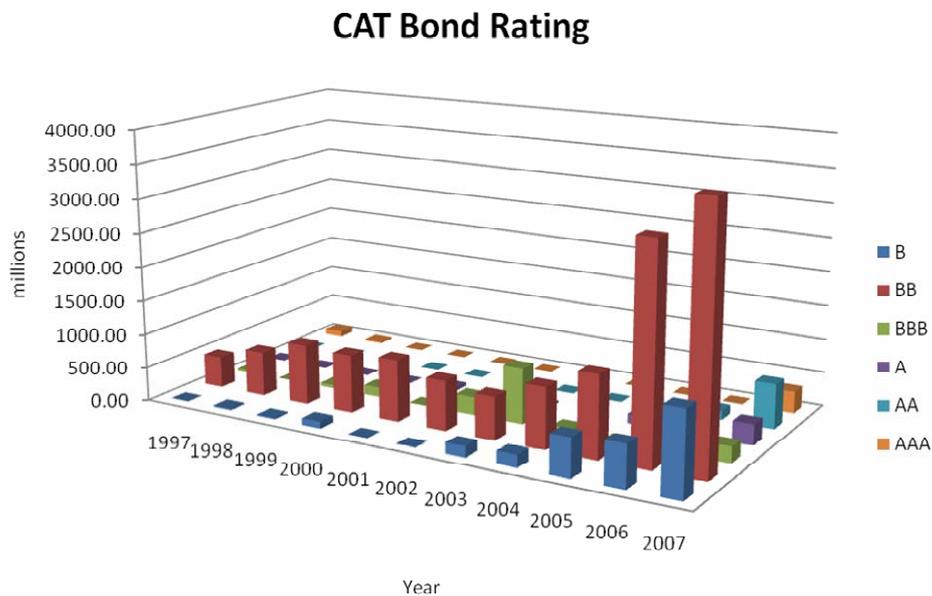


Figure generated from data in *The Catastrophe Bond Market at Year-End 2007*, Guy Carpenter & Company, LLC, 2008

⁴⁷ As explained above, the SPV places the proceeds collected from the investors in the bond into a trust that invests in fixed-income securities. The SPV then swaps the investment earnings of the trust against a LIBOR rate minus a fixed spread.

Figure 9b: Number of issues by date and rating

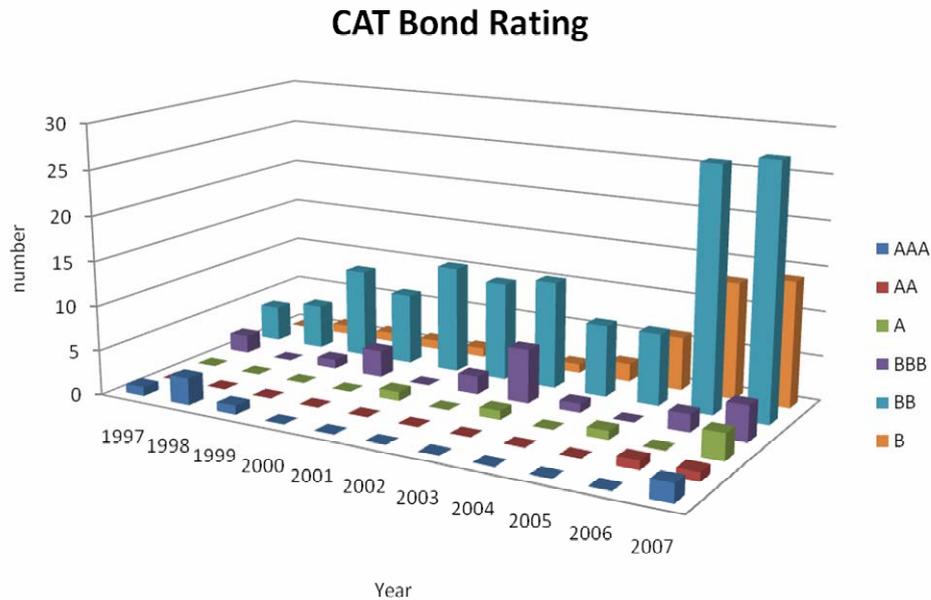


Figure generated from data in The Catastrophe Bond Market at Year-End 2007, Guy Carpenter & Company, LLC, 2008

e) Pricing of CAT-linked securities

i. Theoretical considerations

The pricing of CAT bonds and other CAT-linked securities is perhaps the most investigated area of academic research in this field. Some research uses an actuarial approach to model the yield paid on CAT-linked securities. The equilibrium models imply that disaster risk should yield an unbiased estimate of expected loss. This pricing approach, however, relies on the recognition that equilibrium models do not explain why yields on CAT bonds consistently exceed actuarially fair levels. Academics differ on the determinants of CAT-linked securities risk premium spreads. For CAT-linked instruments, the premium is most commonly determined as a fixed constant times the volatility of loss (other higher loss distribution moments, such that skewness, may also partly determine the premium spread). Others attribute high yields paid on CAT-linked securities structures to the uncertainty associated with actuarial probabilities. On the other hand, Froot and Posner⁴⁸ argue that the pricing of risks in CAT-linked securities structures, (and therefore the determination of risk premium spreads) is determined by reinsurer issuers that possess some market power due to their position as market makers.

Other research uses a financial approach to model CAT bonds and other insurance-linked securities structures. Vaugirard⁴⁹ uses an arbitrage approach to value insurance-linked securities, which accounts for catastrophic events and interest rate randomness, notwithstanding the fact that markets are incomplete. Cox & Pedersen⁵⁰ recognise that

⁴⁸ Froot and Posner (2000).

⁴⁹ Vaugirard (2003).

⁵⁰ Cox, Pedersen et al. (2000).

the pricing of CAT bonds requires an incomplete market setting and develop a pricing method based on a model of the term structure of interest rates and a probability structure for the catastrophe risk.

ii. Practical considerations

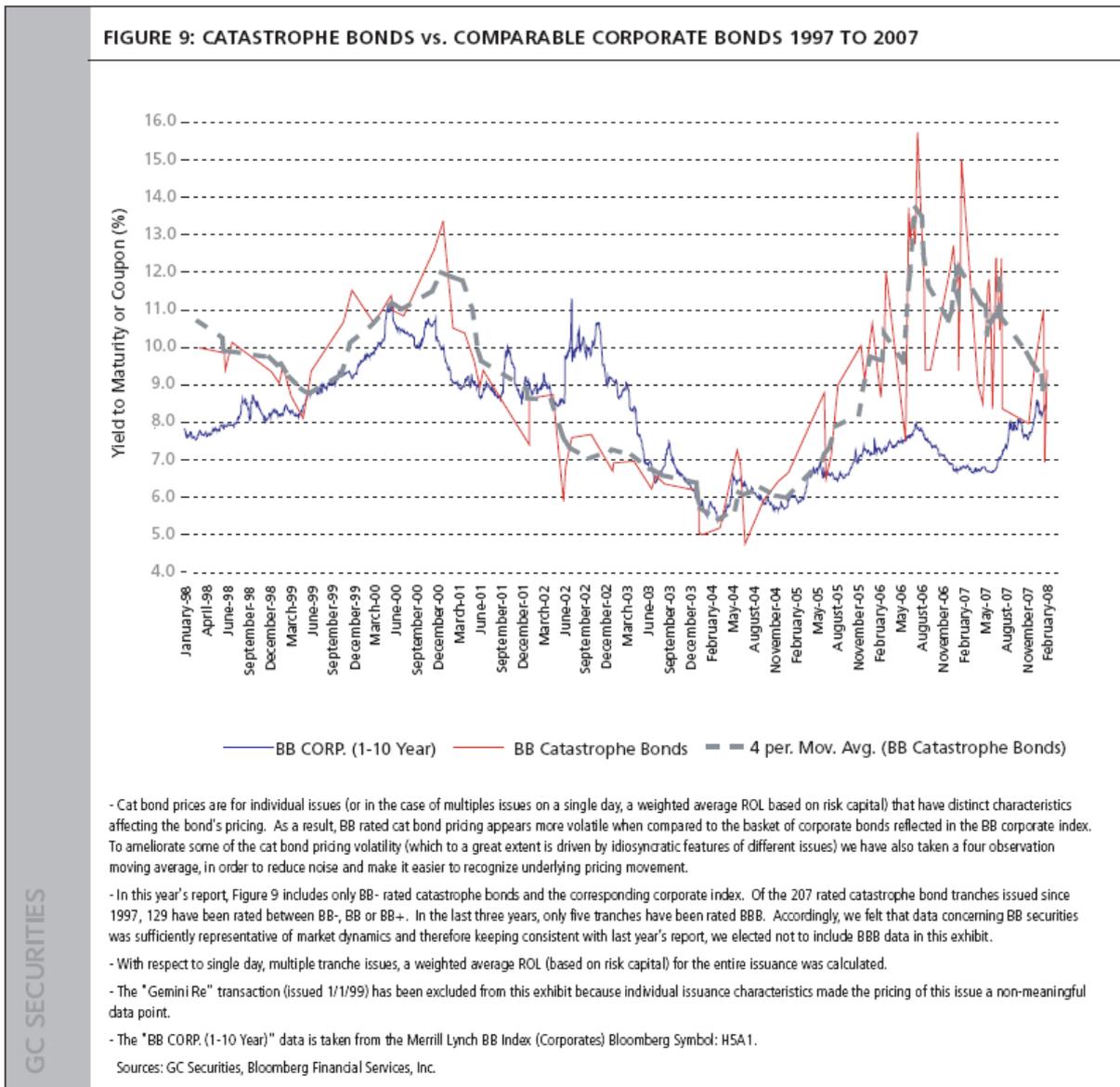
As evidenced in Figure 10, from 2004 until May 2007, CAT bonds traded with a wider spread than similarly traded corporate securities. Markets participants routinely attributed the wider spread to the following factors:

- Doubts by investors about the models used to predict loss probabilities, i.e. the estimated probability that a trigger will be reached⁵¹.
- The perception that the risk associated with CAT bonds may be more binary than that of corporate bonds (i.e., the perception that the loss is all or nothing).

Since May 2007, the difference between corporate bond spreads and CAT bond spreads has narrowed considerably, due mostly to the impact of the sub-prime mortgage meltdown on the pricing of credit risks. Guy Carpenter (2008) notes that corporate bond yields on BB-rated credits jumped significantly in the second half of 2007, compared to a relatively quiet first half of 2007. In the meantime, CAT bond yields continued to decline. As mentioned above, in the current financial crisis environment several factors contributed to the increase in the cost of CAT-linked securities.

⁵¹ After Katrina hit, the doubts were driven by a perceived under-estimation of losses; catastrophe modelling firms revisited their assumptions about hurricane activity rates, and property vulnerabilities, embedded in the CAT models that they had used to rate CAT bond offerings prior to the occurrence of the hurricane.

Figure 10: Comparison of CAT bond yields and corporate bonds yields (Source: Goldman Sachs)



4. Key drivers of, impediments to and issues in the development of CAT-linked securities

We can draw from observations made in section two of this report about the nature of natural catastrophe risks and their economic costs, the general conditions for market growth and liquidity in securitised markets and the possible roles of CAT-linked securities, to identify the key drivers of, impediments to and issues in the development of a CAT-linked securities market.

4.1. Drivers

a) Demand for additional risk transfer capacity

Section two documents the need by insurers and reinsurers for additional risk transfer or risk financing capacity. Growing CAT bond issuance in the pre-financial crisis environment supports the statements made in that section: in 2007, many insurers already participating in the CAT-linked security market tapped the investment community again; for instance, Hartford, Liberty Mutual, SCOR and USAA executed their third, third, fourth and eleventh catastrophe bonds respectively. Allstate, Travelers and Chubb are among the major primary insurers who established shelf programs for the first time. Also, in 2007, after a long absence from the CAT bond market, State Farm sponsored a US\$1.1 billion CAT bond. Finally, issuance of CAT-linked securities by reinsurers remains strong. Guy Carpenter (2008) estimates that reinsurer-sponsored transactions outpaced insurer-sponsored transactions 16 to 10 in 2007, as has commonly been the case throughout CAT bond market history.

When asked about future growth in the CAT-linked securities markets, some industry participants foresee demand for additional risk transfer capacity emerging from second-tier insurance companies, and from reinsurance companies that can synthetically “blend” their insurance clients’ risk portfolios and transfer the blended risk to capital markets.

Industry contacts also mentioned the possible role of state catastrophe pools that may securitise their extreme event risk rather than finance it with taxpayer money.

Finally, demand for additional risk transfer capacity and securitisation may emerge from countries that have huge exposure to catastrophe risks, a constrained financial ability to absorb the financial impacts of financial disasters, and/or an inexistent or inefficient reinsurance market infrastructure. A recent illustration is the newly established Caribbean Catastrophe Risk Insurance Facility (CCRIF). The CCRIF functions as a mutual insurance company controlled by participating Caribbean governments (with some support from donor partners and guidance from the World Bank). The CCRIF pools catastrophe reserves from participating governments, and transfers some of its natural disaster risks to reinsurance markets or capital markets via the use of CAT bonds.

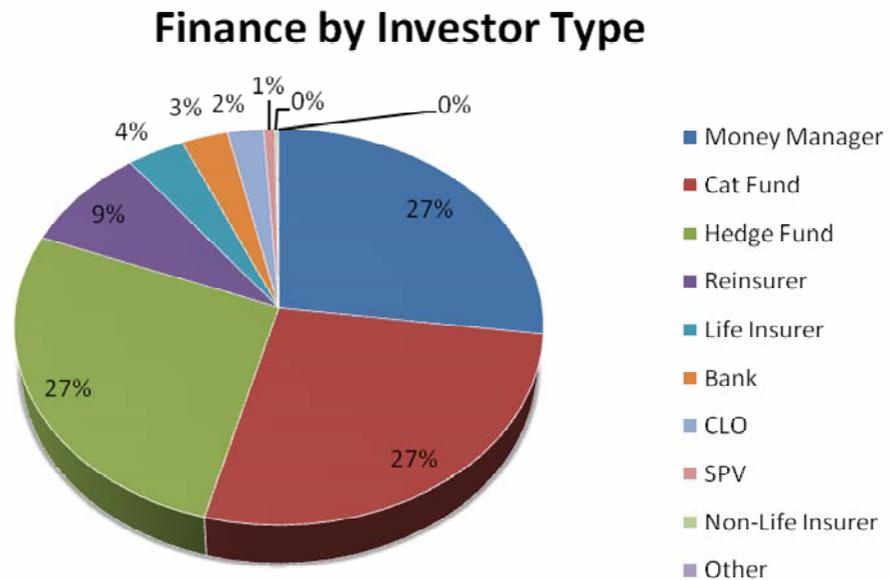
b) Broader investor base and portfolio diversification benefits

Diversification of market participants is a key driver of growth in securitised markets. In the last two years, the number of investors in the CAT-linked securities market has increased and diversified, as a result of a better understanding of the functioning of this market and of more sophisticated assessments of the financial impacts of catastrophe risks. The CAT bond market has a growing core of experienced investors including money managers, hedge funds, dedicated CAT funds, banks, reinsurers, life insurers, non-life insurers, and some money funds, (i.e., see figure 11a and 11b for a breakdown by investor group and country in transactions placed by Goldman Sachs in 2007).

Since CAT bond structures trade over the counter, the secondary market is less transparent than the primary market and liquidity estimates vary considerably. Industry estimates of market participation range from scores to hundreds of investors. Figure 11a shows that the proportion of the capital raised by Goldman Sachs in 2007

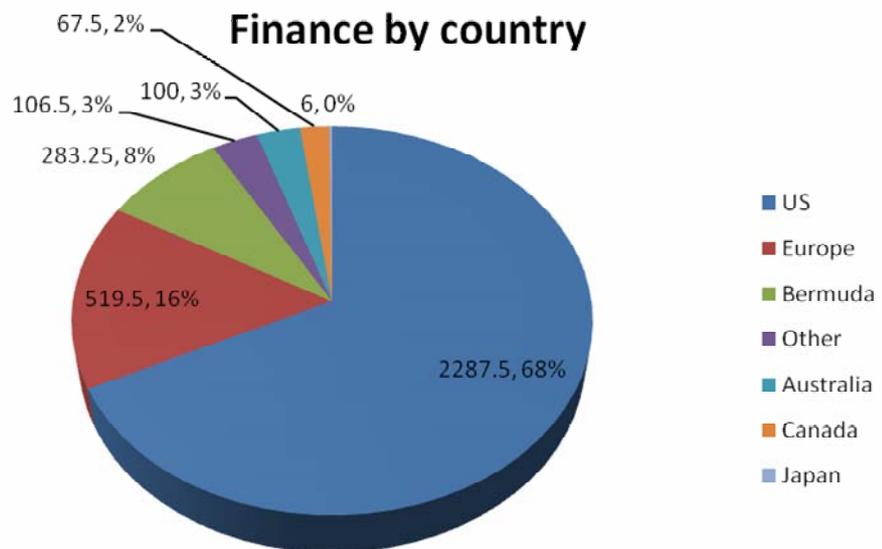
came primarily from money managers, CAT funds and hedge funds, i.e., those groups financed approximately 81 percent of the CAT-linked issues.

Figure 11a: Investor base



Source: Goldman Sachs, May 2008

Figure 11b: Investor base by country



Source: Goldman Sachs, May 2008

The risk-return profile of CAT instruments is a determinant of demand. All managers of institutional portfolios must decide whether to include an asset such as a CAT bond based on its expected return and its correlation. We have seen in Figure 10 that CAT bonds provide rates of return historically greater than similarly rated corporate bonds; hence the CAT instruments provide some excess return necessary for risk bearing. Corporate capital has always been present in the aftermath of a large disaster for the right risk-return profile.

For instance, in 1992, following the occurrence of Hurricane Andrew, a large injection of capital in the form of newly formed reinsurance entities in Bermuda was observed. Similarly, the occurrence of Hurricane Katrina provided the catalyst for growth in the CAT-linked securities market. Today, there are many dedicated CAT funds investing solely in CAT risks. Examples of such funds are: Stark Investments, Fermat, Nephila, Magnitar, Pulsar and Coriolis. Finally, hedge funds such as Citadel Investment Group, Fortress and JWM have focused on equity participation by investing in sidecars and other equity-related instruments.

That said, it is observed, however, that the most recently issued CAT bonds have tranches with ratings primarily in the B to BBB range. Lower ratings-higher yields securities may attract investors like hedge funds or CAT funds from a risk-reward standpoint, but may deter investors looking for A to AAA-rated securities. Investors in highly rated securities constitute the vast majority of investors in other securitised markets, such as the MBS or ABS markets.

Moreover, it is worth noting while individual and less sophisticated investors can, in theory, assume CAT via participation in mutual funds, only a few mutual funds, to date, specialise in natural disaster risk. While it seems obvious that both better price transparency and greater transparency in the underlying risks are crucial to enhanced secondary market trading, the institutional community shows little interest in opening up the CAT-linked securities market to smaller or individual investors. In addition, the high costs of CAT risk assessment may be prohibitive to some investor types.

Although CAT bond yield spreads have recently narrowed compared to traditional corporate debt spreads, CAT-linked securities have historically provided a favourable risk and return profile to investors and, more importantly, have provided them with a means of reducing portfolio risk.

More specifically, there is evidence that CAT bonds exhibit low correlations with other asset classes. For example, Froot⁵² estimates of the correlation coefficients between CAT exposures and other asset classes ranged from -0.13 and $+0.21$ but none were statistically different from zero. The favourable risk-return profile of this class of securities demonstrates that the CAT-linked securities may be used to reduce the risk of a portfolio and increase its expected return. More recently, Heike and Kiernan⁵³ have shown "that the addition of a small allocation of cat bonds to a BB high-yield portfolio, represented by the Lehman Brothers BB High Yield Index,

⁵² See Froot, K. A., B. S. Murphy, et al. (1995). *The Emerging Asset Class: Insurance Risk*, Guy Carpenter. Also see Litzenberger, R. H., D. R. Beaglehole, et al. (1996). "Assessing Catastrophe-Reinsurance Linked Securities as a new Asset Class." *Journal of Portfolio Management*: 76-86.

⁵³ Heike and Kiernan (2002).

reduces the portfolio's return volatility and boosts its expected return".⁵⁴ Hence, portfolio diversification provides a rationale for the growing investor base for this asset class.

The recent sub-prime mortgage and credit market crisis in U.S. financial markets further highlights the attractiveness of zero-beta assets, like CAT-linked securities, in investor portfolios. Institutional investors have recently become re-acquainted with the dangers of holding securities collateralised with highly correlated assets and have shied away from mortgage-collateralised bonds or CDO, while turning to the CAT-linked market. This increased investor's interest partly explains the recent narrowing of CAT bond yields compared to yields on comparable traditional corporate debt (see Figure 10).

c) Advances in technology and modelling of CAT risk

As mentioned in section two, advances in technology and modelling also contribute to better public understanding and acceptance of securitised products. Today, thanks to advances in catastrophe modelling and risk assessment methodologies, both bond sponsors and institutional investors have a more sophisticated understanding of the financial impact of the risk embedded in various CAT-linked structures. In response to the financial impact of Katrina on the insurance and reinsurance industries in 2005, the leading CAT modelling firms, i.e., AIR, EQE and RMS, refined their modelling techniques to account for larger losses than those predicted. This increased awareness of potential losses has helped increase the search for capacity in the insurance industry and has driven sponsorship of CAT-linked securities. In addition, catastrophe modelling firms have reduced their wind prediction horizon to near-term probabilities, i.e., 5-year horizon as opposed to 25 -100 years.

The development of software technology aimed at facilitating the management of portfolio of catastrophe risks can also be observed. For instance, AIR has recently developed CATRADER®, a software tool that may appeal to both sponsors and investors in the CAT-linked securities market. In particular, according to AIR, the software provides investors with the ability to structure and evaluate securitised CAT transactions and enables the testing of portfolio optimisation strategies. RMS has also released a licensed software product "Miu" that allows investors and issuers to quantify and tailor a portfolio of catastrophe risk positions packaged in any form: CAT bonds, OTC derivatives, sidecars, ILWs, and various forms of reinsurance.

d) Broader sponsor base: corporate/sovereign issuers

⁵⁴ See Samuelson, P. A. (1967). "General Proof That Diversification Pays." *Journal of Financial and Quantitative Analysis* 2(2): 1-13. Also see , MacMinn, R. D. (1984). "A General Diversification Theorem." *Journal of Finance* 39(2): 541-50, which shows the conditions under which adding an asset to a portfolio will reduce the risk of the portfolio.

⁵⁵ See Monti A., *Policy Approaches to the Financial Management of Large-Scale Disasters*, in 'Financial Management of Large-Scale Catastrophes', cit.

⁵⁶ It seems, however, that sidecars are popular structures in "hard" insurance markets and much less so in "soft" markets as evidenced by the dwindling amount of sidecar structures observed in 2007.

⁵⁷ See <http://www.perils.org>

⁵⁸ Catastrophe Risk Evaluation and Standardizing Target Accumulations (CRESTA); see www.cresta.org.

At the beginning, CAT risk securitisation transactions were sponsored only by insurance and reinsurance companies, but the investor base grew over time. Besides insurers and reinsurers, there have been few corporate issuers of CAT bonds to date: Tokyo Disney, Universal Studios and Électricité de France are among a handful of corporations that have sponsored CAT-linked securities. Industry sources attribute such low interest to three factors:

- First, for most corporations, insurance costs are generally cheaper than the costs of transferring natural disaster risk via capital markets. Insurance pricing benefits corporate buyers because the insurer can pool and spread corporate risks.
- Second, while the pooling argument breaks down when peak risks arise, very few corporations around the world have peak risk exposures.
- Finally, applicable accounting rules may deter corporations from issuing CAT-linked securities.

As noted in section two, some level of public sector participation may facilitate the growth of securitised markets. To date, government participation in the CAT-linked securities market has remained very limited.

The newly established CCRIF provides a good but isolated example of possible government participation in the CAT-linked securities capital markets. Those governments that have a constrained financial ability to absorb the economic impacts of natural hazards could tap CAT-linked securities markets either by directly issuing CAT-linked securities (like the sovereign-backed Cat-Mex US\$160 million issued by the government of Mexico in 2006) or by creating multi-governmental facilities similar to CCRIF. The latter would allow these governments to share the costs of accessing reinsurance and capital markets and the costs of the CAT modelling technology, with a view to transferring extreme event risks from the pooling facilities to capital markets via the issuance of CAT-linked securities.

Since, as discussed, CAT risk securitisation transactions very often entail some degree of basis risk, it becomes crucial to determine the objectives pursued by the sovereign sponsor. The CAT bond issued in May 2006 on behalf the Mexican government, for instance, is mainly aimed at providing the necessary liquidity for emergency response measures, not at covering the losses caused by a severe earthquake. A similar objective is pursued by the CCRIF, launched under the auspices of the World Bank, which allows Caribbean governments to purchase parametric insurance coverage that will provide them with an immediate cash payment after the occurrence of a major hazard event, thus enabling them to overcome the liquidity crunch that may follow a disaster and start recovery operations without delays.

In OECD countries where private insurance and reinsurance markets are well developed and their activity is organised and coordinated in the context of an integrated disaster risk management strategy,⁵⁵ governments could develop pools of reserves from private insurers to cover extreme event catastrophes risks, and finance a portion of these pools via the issuance of CAT-linked securities, rather than via the use of taxpayer money.

Moreover, in countries that have high exposure to catastrophe risks, a constrained financial ability to absorb the financial impacts of financial disasters, and/or an inexistent or inefficient reinsurance market infrastructure, governments should

investigate the extent to which CAT-linked securities would provide one of the means of hedging the risk of uninsured economic losses.

At a more general level, it shall be noted that an increasing number of sponsors are now fully integrating CAT-linked securities into their overall risk management strategy rather than seeking capital market protection as a defensive or last resort tool. As pointed out by Guy Carpenter (2008), “the record market activity of 2007 demonstrates a fundamental shift in the perception of the capital markets as a risk transfer solution.” Industry sources corroborate this view and observe an increased desire by sponsors to evaluate all risk transfers mechanisms equivalently. In 2007, several sponsors, who had until then avoided what they perceived to be costly CAT bond structures, issued CAT bonds, despite the fact that the reinsurance market was in a soft cycle. In the current crisis environment, the situation is less clear.

4.2. Impediments

Each existing CAT-linked structure has its own weakness. Overall, there are common factors that may have limited the growth and liquidity of CAT-linked securities and derivatives markets.

a) Market fragmentation / lack of standardised transactions

A certain degree of standardisation in market capital structures is critical for the development of CAT-linked securities. In section two, it was noted that standardisation enhances market liquidity and helps investors manage their portfolios more efficiently. Yet, it was observed previously that, in issuance terms, the CAT bond market is almost evenly split between indemnity structures and non-indemnity structures. This partly explains the current fragmentation of the CAT-linked capital markets. In addition, and to a certain extent, CAT-linked capital structures seem to have become more complex with an evolution from fairly simple CAT bond structures, to CRO (reminiscent of CDO in credit markets), to sidecars⁵⁶. However, secondary market liquidity generally increases as more standardised structures (i.e., structures with a payoff triggered by an index of pooled risks) appear in the capital markets.

It seems that, after a couple of years spent on introducing more complex instruments, CAT-linked securities market participants have come to the realisation that simpler CAT bond structures may remain the dominant form of CAT-linked securities. Despite the diversity of triggers, CAT bonds are more “standardised” than other capital structures as evidenced by the increased number of shelf registrations.

From the sponsor’s standpoint, industry loss triggers tend to have less embedded basis risk than parametric triggers. Yet a bond or a derivative instrument triggered by an industry loss will not offer immediate payout to investors, as losses will develop over weeks and possibly months, especially losses resulting from large events like Hurricanes Andrew or Katrina. In addition, the methodology for collecting and aggregating insured losses may be deemed inadequate. For instance, some CAT-linked securities market participants feel that the existing industry loss triggers (i.e., PCS) are inadequate in their estimation of U.S. natural catastrophe insured losses. If so, then consideration should be given to the development of a new methodology for gathering industry loss and industry market exposure information for catastrophe losses.

A recent effort by a group of European reinsurers established a Swiss-based entity,

PERILS AG (“PERILS”), whose aim is to aggregate and provide industry-wide European catastrophe insurance data as a subscription service.⁵⁷ The methodology envisioned by the group in collecting industry loss data is similar to that used by PCS. PCS estimates industry losses by surveying U.S. insurers who had exposure in the disaster zone once the catastrophe occurred. It collects information on the number and average size of direct claims that an insurer expects to pay and aggregates this information across insurers. The European group would attempt to collate the same information, but based on industry loss and insured exposure numbers from disaggregated data collected by CRESTA zone, i.e., more at a U.S. county level.

b) Lack of standardised data-gathering

One of the constraints on the development and expansion of the CAT-linked securities market has been the need to have a high quality CAT loss model for that region and peril. As the availability of such models has expanded since the late 1990s, so the range of countries and perils served by CAT-linked securities issuance has itself expanded. For example, the first European windstorm securitisation in 1998 was based on the availability of trusted second-generation CAT loss models for the peril. The decision for the risk modelling companies to build a CAT model for a new country and peril is based first on the commercial assessment that the insurance and reinsurance interest in that territory is of sufficient size to merit the investment. The quality of the model will then chiefly be determined by the depth and detail of the historical record and the availability of high quality information on recent loss data for calibrating vulnerabilities relevant to the local building stock. Inevitably, therefore, there are many developing countries and perils for which there is no CAT model, or a model considered too rudimentary to support issuing a CAT-linked security. In a developing country, without relevant institutions of meteorology and geology, there will also typically be far less actual monitored observational and historical data on which to base the model. CAT models only perform well if insurers are themselves able to collect high-quality data on the insured when they underwrite the risk, and in many territories the insurers themselves do not have the tools to collect such data.

As a result, issuance of CAT-linked securities may remain limited for some peril types and geographic areas because the available CAT models do not exist, or are not considered sufficiently robust. These problems will be particularly exacerbated for indemnity CAT-linked securities structures, as there will also likely be distrust of exactly what data has been available to be fed into the model for the analysis as well as exactly how claims management will be maintained in the aftermath of a major catastrophe.

For this reason, parametric CAT-linked securities structures tend to be favoured for developing countries by rating agencies and investors. Parametric triggers have always tended to be more attractive to sophisticated investors, who understand that the modelling for these triggers will involve significantly less uncertainty than for indemnity deals. It is easier for an investor to understand the basis of the modelling than industry loss triggers, in that they do not assess the insured exposure and vulnerability of the building stock, or undertake a comprehensive assessment of all the sources of loss, which are required to capture the financial impact of a natural disaster.

In addition, capital market structures triggered by parametric measures can be settled within weeks of a potential loss, unlike indemnity or industry loss deals that may take

up to 18 months before the final loss is known. Even for the issuer, the advantage of the speed of settlement may be a significant factor in choosing a parametric structure. Also, by using second-generation parametric structures involving recorded measurements, it is possible to apply weightings to each instrumental value when constructing an overall index for the event to match the geography of the underlying portfolio of properties (and any localisation of vulnerability), so that it becomes possible to create an index that more closely matches the losses being modelled. This reduction of basis risk also makes such structures more attractive to the issuer. Second-generation triggers have been employed for issuing securitisations: in the U.S. for California earthquake, in Japan for earthquake and typhoon wind, in the U.K. for windstorm and flood (using flood heights preserved on buildings within the construction of the index), and in Western Europe for windstorm.

Given the relative advantages of second-generation parametric structures, the main deterrent to their wider use, especially in developing countries, concerns the availability of a suitable dense network of hazard (wind speed, river height and earthquake strong motion) recording stations and, most importantly, recording procedures. There may, for example, be no guarantee that wind speed recorders will continue to record through intense tropical cyclones, because the equipment will have been dismantled and stored to protect it from damage. Also, it is common that the duration of battery power to cope with an inevitable loss of offsite power is insufficient to record through the passage of the storm. River flow gauges are often destroyed in extreme floods, and earthquake strong motion instruments also rely on batteries that require renewal every few months. Therefore, the expansion of second-generation triggers to new territories requires that government agencies of meteorology, hydrology and seismology (or even private companies in these areas) have appropriate standards regarding the installation and management of their networks of instrumental recorders.

There are three required components in this respect. First the choice of instrumentation and instrument siting must be sufficiently resilient to withstand the strongest potential hazard. Wind speed recorders designed to monitor wind speeds at airports, for example, are generally insufficiently robust to withstand a hurricane. Second, instruments should be spaced every 10-20 kilometres to ensure that the overall hazard field of an earthquake or windstorm is fully captured and that there is redundancy of observation (where a station fails to record). Third, there needs to be a maintenance guarantee for the equipment, batteries must be checked and replaced regularly, and the recording procedures tested to ensure they operate under all conceivable adverse conditions.

A government that chooses to support this level of instrumentation, recording, and reporting will provide the foundation for the use of second-generation parametric triggers in risk transfer. In particular, in the developing world, where information on property values, building types, and locations may be much harder to obtain, such risk transfer structures may provide the only effective way of designing a satisfactory risk transfer mechanism that does not suffer from a potentially large basis risk – as can be the case with first-generation parametric structures based only on earthquake magnitude or tropical cyclone intensity and track.

As mentioned above, a new standardisation effort was recently made by a consortium of European reinsurers that established PERILS, whose aim is to calculate, monitor, and distribute to subscribers industry indices that would track aggregate losses

incurred from European wind risk and industry market exposures based on CRESTA⁵⁸ zones. PERILS has been established to aggregate and provide industry-wide European catastrophe insurance data as a subscription service. The aggregated data sets will be derived from data voluntarily provided by European-based insurers. From January 2010, PERILS will provide two main products to subscribers which are likely to include insurers, reinsurers, brokers, risk modellers, banks and other insurance industry stakeholders. These two products are: (i) aggregated industry-wide insurance exposure data (insured values), which will be catalogued by risk type and CRESTA zones (defined European geographical zones for natural catastrophe insurance). The data will be provided on an annual basis; (ii) industry loss estimates per risk type and CRESTA zones, following large natural catastrophe events. Overall, the combination of consistent industry exposure portfolio data and corresponding event loss information is likely to enhance the modelling of natural catastrophe risk. Greater transparency on industry losses will also further facilitate the establishment of accurate and robust loss triggers for catastrophe bond structures, ILWs and other capital markets products.

c) Lack of transparency in the underlying risk and valuation complexity

To date, the CAT-linked securities market has remained opaque to the general public. CAT-risk transferred to investors via CAT-linked securities is assessed by complex risk models developed by specialized firms: valuation of CAT-risks, therefore, requires specialised knowledge and an understanding of such models. Transparency and reliability of risk modelling are a crucial factor in the development of this market. As mentioned above, advances in catastrophe modelling and risk assessment methodologies allow bond sponsors and institutional investors to progressively develop a more sophisticated understanding of the financial impact of the risk embedded in various CAT-linked structures.

It shall also be noted that there is no public dissemination of bond offerings or prices as transactions occur OTC. As noted above, the CAT-linked securities market is likely to remain opaque if only open to institutional investors. This said, the institutions currently involved in the CAT-linked securities market might not perceive market opacity as an impediment to market growth because it is not an issue for them. They circulate lists of bond offerings and related pricing among themselves or their customers, as is common in the OTC market. They can argue that information on bond offering and bond prices is available, but that it is not publicly disseminated.

Exchange-traded CAT-linked derivatives markets have also remained opaque, with the exception of the CCFE. The CME and NYMEX do not post price and volume information on their websites. Real-time price quote providers also do not carry this information. By contrast, the CCFE provides price and volume information on its website. Opening access of the CAT-linked securities market to a broader base of investors would require public dissemination of offerings, prices, and other information related to the risk associated to investing in CAT-linked securities.

4.3. Issues

a) Cost comparison

The jury is still out on how costly CAT-linked securities are, from an issuance standpoint, compared to traditional reinsurance or ILW. In its report on managing

large-scale risks, the Wharton Risk Management and Decision Processes Center⁵⁹ notes that “from a single rate-on-line perspective, it is true that insurance-linked securities bear a higher cost than that of reinsurance or retrocession. However, there are exceptions for specific risks like higher tranches of retrocession and peak exposures in high-risk prone areas”.

Typically, the one-time costs associated with issuing CAT bonds are higher than those that apply to regular debt securities. Most CAT-linked securitisation transactions have been structured via the use of SPVs that are generally based offshore. Although SPVs tend to simply operate trust accounts, there are significant transactions costs associated to the issuance of CAT bonds such as higher fees charged by rating agencies which devote more time and manpower in analysing CAT bond structures than regular debt structures, and fees charged by CAT modelling firms. Yet overall, the legal fees associated with issuing CAT bonds have declined with the increasing proportion of shelf registrations of CAT-linked securities⁶⁰.

Indemnity-triggered bond transactions are generally - but not always - costlier than non-indemnity-triggered bond transactions. As noted by Guy Carpenter (2008), indemnity triggered bonds first require the payment of a higher risk premium to the investor relative to non-indemnity bonds. The size of the premium is a function of the type of business covered and the investors’ confidence in the sponsor’s underwriting, risk management, and loss and claims adjustment process. Second, there are additional costs embedded in indemnity-based structures resulting from disclosure requirements, the level of detail required on the underlying insured exposure in terms of nature and locations of the properties and their insurance coverage required to model the risk, and perceived legal exposure.

In any case, it is very difficult to accurately compare the cost of traditional reinsurance and the cost of CAT-linked securities⁶¹, since:

- CAT bonds are multi-year programs that address price volatility issues;⁶²
- CAT bonds, especially the most recent structures, entail lower counterparty

⁵⁹ Doherty, N. A., G. M. F., et al. (2008). *Managing Large-Scale Risks in a New Era of Catastrophes: Insuring, Mitigating and Financing Recovery from Natural Disasters in the United States.* , Wharton Risk Management and Decision Processes Center.

⁶⁰ Lane and Beckwith (2007).

⁶¹ See *Convergence of Insurance and Capital Markets*, World Economic Forum, October 2008, cit., at 23.

⁶² The volatility of reinsurance and retrocession prices impacts the market for CAT-linked securities. At larger volatility levels, the multiyear CAT bond gains a strategic advantage by providing coverage at a known price. Price stability in risk coverage enhances the insurer or reinsurer’s ability to invest in new business or expand current business. This then allows the creation of value at an advantageous time that might not otherwise be possible. Equivalently, the CAT bond solves a corporate underinvestment problem: see Froot, K. A., D. S. Scharfstein, et al. (1993). "Risk Management: Coordinating Corporate Investment and Financing Policies." *Journal of Finance* 48(5): 1629-58, Garven, J. R. and R. D. MacMinn (1993). "The Underinvestment Problem, Bond Covenants and Insurance." *Journal of Risk and Insurance* 60(4): 635-646, MacMinn, R. D. (2005). *The Fisher Model and Financial Markets*. Singapore, World Scientific Publishing. See also Helfenstein and Holzheu (2006) who argue that the multi-year nature of CAT bonds provides fixed-cost coverage over a multi-year period, while reinsurance premiums are much more sensitive to insurance cycles.

risk than traditional reinsurance;⁶³

- Non-indemnity CAT bonds may allow for a much faster settlement of the payments due in the event of loss, with advantages to both sponsors and investors and a saving of time and cost;
- Non-indemnity CAT bonds entails some degree of basis risk, which can be reflected in the pricing of these instruments;
- CAT bonds rarely include reinstatement provisions, a typical feature of traditional reinsurance.

b) Trade-off between moral hazard and basis risk

Securitisation of risk becomes more successful when the capital structure provides an equal playing field between risk transferors and risk takers. In the CAT-linked market, there could be a lack of “dual” coincidence of wants between the insurer and the investor. As explained previously, CAT-linked securities may have a payout tied to indemnity or non-indemnity triggers (i.e., parametric triggers or industry loss triggers).

Indemnity-triggered instruments appeal to sponsors because they reduce or eliminate basis risk. On the other hand, non-indemnity based capital structures may be more attractive to an investor than indemnity instruments, as the use of an industry loss index trigger or a parametric trigger minimises moral hazard costs. Index structures also are likely to lower investors’ costs in evaluating company-specific underwriting and financial results. Company-specific capital structures, moreover, might be conducive to adverse selection and moral hazard. Adverse selection in the context of insurance securitisation reflects the fact that an insurer could securitise the most unattractive parts of its portfolio and keep the most profitable ones. Moral hazard relates to the fact that the insurer who transfers its risks to the investor via the capital market might no longer have an incentive to limit its losses.

Although relatively new in insurance markets, basis risk is well known in the financial markets, as it represents a risk inherent in all commodity and financial transactions based on a standardised financial asset or commodity, or on an index of these. The issue per se is not the existence of basis risk, however, but its assessment and quantification. Once thoroughly quantified, if possible, basis risk in a financial transaction can be minimised and almost eliminated. For instance, it is common to use derivative instruments to eliminate basis risk in security or commodity portfolios via “over-hedging” or “under-hedging”.⁶⁴

The novelty here is that, with respect to CAT-linked securities, it is much more difficult to assess the anticipated impact of a catastrophic event on an insurer’s portfolio than to assess the market risk or interest rate risk of a specific security and to

⁶³ Often catastrophe reinsurance claims for peak perils coincide with times of industry distress, while CAT bond proceeds are invested in highly rated securities, thus reducing counterparty risk.

⁶⁴ The terms “over-hedging” and “under-hedging” refer to the process of transacting a higher or lower number of derivative contracts than the number that would be necessary for a company to perfectly hedge its exposure. Over-hedging and under-hedging examples using catastrophe insurance options can be found in the CBOT PCS Catastrophe Options User’s Guide (1995, p. 35-36).

compare it to that of a standardised hedge instruments like a futures contract.

In a 1999 report commissioned by the National Association of Insurance Commissioners (NAIC), the American Academy of Actuaries argues that it is possible to statistically identify and measure the basis risk embedded in hedging transactions performed with index-based securities.⁶⁵

In addition, empirical evidence has supported the hedging effectiveness of non-indemnity instruments, despite the existence of basis risk^{66,67}. However, these studies must be assessed with caution. Findings can vary based on the statistical method used, e.g., simulation models versus analysis of historical data, and on the source of basis risk embedded in a specific derivative transaction. Recent research has also focused on the benefits of index-triggered bonds in comparison with indemnity-triggered bonds. In a highly stylised model, MacMinn and Richter⁶⁸ show that, under some circumstances, reinsurers who issue bonds to hedge against brevity risk (i.e., the risk of premature death) achieve greater shareholder value by utilising index-triggered securities instead of indemnity-based securities.

As noted above, recent history in the CAT-linked securitisation market shows increased confidence by issuers of CAT bonds in index-based triggers; see Figures 7a and 7b for historical issuance of bonds by trigger type. Sponsors, with the help sometimes of reinsurance brokers, have spent a lot of time and resources understanding their exposures to basis risk. Meanwhile, investors have become increasingly comfortable with indemnity-based capital structures. Some of them now tend to recognise indemnity risk as another risk component in a transaction, provided that they have a sufficient grasp of catastrophe modelling techniques and a good level of comfort with bond sponsors.

Finally, while moral hazard exists in indemnity-based capital instruments, CAT bonds can be structured to minimise its impact. For instance, a structure involving co-insurance or payment of the premium upfront rather than in arrears may help to mitigate moral hazard.

This explains why, in dollar issuance terms, the CAT bond market is now almost evenly split between indemnity versus non-indemnity triggered securities in terms of issuance.

⁶⁵ American Academy of Actuaries Index Securitization Task Force, "Evaluating the Effectiveness of Index-Based Insurance Derivatives in Hedging Property/Casualty Insurance Transactions" (American Academy of Actuaries, October 1999).

⁶⁶ See, for instance, Major, J. A. (1999). Index Hedge Performance: Insurer Market Penetration and Basis Risk. The Financing of Catastrophe Risk. K. A. Froot. Chicago and London, University of Chicago Press: 391-426. Also see Harrington, S. and G. Niehaus (1999). "Basis Risk with PCS Catastrophe Insurance Derivative Contracts." Journal of Risk and Insurance 66(1): 49-82.

⁶⁷ A detailed discussion of the topic is beyond the scope of this report. An overview and discussion of the regulatory and accounting treatment of insurance-linked instruments can be found in Bouriaux (2001).

⁶⁸ MacMinn, R. and A. Richter (2004). Hedging Brevity Risk with Mortality Based Securities. Normal, Illinois State University.

c) Regulatory and solvency issues

The future development of CAT-linked securities markets also depends on how lawmakers will address a number of key accounting, solvency and regulatory issues going forward. In this respect, key questions include:

- To what extent should regulated insurance and reinsurance companies be allowed to obtain capital relief for transfers of CAT-risks by way of securitisation on terms that are consistent with other methods of transferring risks, such as traditional reinsurance or retrocession?
- To what extent should a SPV providing protection to the sponsor of a CAT bond transaction be regulated?

Regarding the first question, comparable levels of capital relief should, in principle, be allowed for comparable levels of risk transfer, irrespective of the legal form of the transaction and the amount of capital relief should reflect the amount of risk transferred⁶⁹. In practice, market fragmentation, lack of standardised transactions, complexity in the valuation of the securitised CAT-risk, and the incidence of basis risk may induce insurance regulators to take a very prudent approach.

With respect to the second question, in theory, if the SPV writes the equivalent of a reinsurance contract to the sponsor, it should be treated as a reinsurance undertaking from a regulatory (e.g., authorisation process, licensing requirements, requisites to carry out the activity) and solvency (e.g., capital requirements, rules on investment of assets covering technical provisions) perspective. However, it should be noted that an SPV will usually enter into a single transaction – or a series of transactions within a shelf offering program – and will not conduct a diversified operating business. Moreover, CAT bond transactions, especially the most recent structures, are highly collateralised, so that counterparty default risk is kept at a minimum.

While a clear and reliable regulatory framework aimed at ensuring that ISPVs are able to fulfil their obligations towards the investors and the sponsor is certainly desirable, since it would guarantee the effectiveness of risk transfer for the purposes discussed above, the structural and functional differences between an ISPV participating in a CAT-linked securities transaction and a traditional reinsurance undertaking should be clearly recognized and reflected in the applicable regulatory and solvency regime.

In this regard, it is interesting to note recent developments that occurred at the European level. In the European Union (“EU”), the Reinsurance Directive (Directive 2005/68/EC) (“RID”) authorised Member States to implement, if they wish, insurance

⁶⁹ CAT-linked securities, insurance and reinsurance, and other ART instruments should receive a regulatory, accounting, and fiscal treatment based on their relative merits and risks. For instance, Bouriaux (2001) compares risk transfer alternatives offered by the capital and insurance markets based on the risks associated to each alternative: basis risk, credit risk, and collateralisation. She notes some inconsistencies in their accounting treatment. Generally, critics of a favourable accounting treatment for non-indemnity insurance-linked securities argue that, unlike reinsurance, these instruments do not achieve full transfer of risk partly because of the existence of basis risk and partly because of the partially funded nature of some of these transactions (i.e., exchange-traded derivatives). Bouriaux points out that (a) basis risk can be identified and quantified and (b) that, in some instances, reinsurance transactions can be less than fully collateralised and funded and yet, in the U.S., the NAIC grants them a favourable accounting treatment.

⁷⁰ For example, in the U.K. the FSA took the view that the term ‘fully funded’ simply means that the ISPV’s reinsurance liabilities must be capped at the value of the assets available to fund those liabilities. Furthermore, the FSA issued guidelines in order to assess the ‘fully funded’ test, including, ultimately, the issue of external opinions to confirm compliance with such guidelines and full subordination of the finance providers to the claims of the ceding insurer or other insurance creditor towards the ISPV. In Germany, the BaFin has taken the view that the present value of the ISPV’s assets must, at any time, be higher than the maximum potential claims of the ISPV arising under the underlying insurance risks. In order to meet such test, the ISPV may enter into hedging agreements. In France, the situation appears to be less clear-cut. French authorities tended to cumulate quantitative and qualitative tests. French ISPVs must be fully funded, i.e. at any time their maximum liabilities resulting from the underlying insurance risks, net of hedging agreements, shall not exceed their assets. However, the authorised investments in French ISPVs could be significantly restricted by quality tests; thus, increasing security for capital market investors and ceding insurers (or other insurer creditors) but reducing the economic interest of the transactions given the limited remuneration normally associated with very high quality/liquid investments. Finally, to reinforce the fully funded principle, the French law envisages to state that agreements entered into by ISPVs in order to transfer insurance risks cannot impose unlimited commitments to the ISPVs. See Touraine H., *European insurance securitisation vehicle; where do we stand, what are the issues?*, Freshfields Bruckhaus Deringer LLP, November 2008.

⁷¹ The text of the amended Solvency II proposal adopted on 22 April 2009 expressly recognizes that: “(63b) *Appropriate rules should be provided for special purpose vehicles which assume risks from insurance and reinsurance undertakings without being an insurance or reinsurance undertaking. Recoverable amounts from a special purpose vehicle should be considered as amounts deductible under reinsurance or retrocession contracts. (63c) Special purpose vehicles authorised before 31 October 2012 should be subject to the law of the Member State having authorised the special purpose vehicle. However, in order to avoid regulatory arbitrage, any new activity commenced by such a special purpose vehicle after 31 October 2012 should be subject to the provisions of this Directive. (63d) Given the increasing cross-border nature of insurance business, divergences between Member States’ regimes on special purpose vehicles, which are subject to the provisions of this Directive, should be reduced to the greatest extent possible, taking account of their supervisory structures. (63e) Further work on special purpose vehicles should be conducted taking into account the work undertaken in other financial sectors.*”

⁷² The new ‘*organisme de titrisation*’ – which is a revised, amended and enhanced evolution of the prior ‘*fonds commun de créances*’ (French securitisation vehicle) – can be created either as a co-ownership (‘*fonds commun de titrisation*’) or as a limited liability company (‘*société de titrisation*’).

⁷³ Solvency II will introduce economic risk-based solvency requirements across all EU Member States for the first time. These new solvency requirements will be more risk-sensitive and more sophisticated than in the past, thus enabling a better coverage of the real risks run by any particular insurer. The new requirements move away from a crude ‘one-model-fits-all’ way of estimating capital requirements to more entity-specific requirements. Solvency requirements will also be more comprehensive than in the past. Whereas at the moment the EU solvency requirements concentrate mainly on the liabilities side (i.e. insurance risks), Solvency II will also take account of the asset-side risks. The new regime will be a ‘total balance sheet’ type regime where all the risks and their interactions are considered. In particular, insurers will now be required to hold capital against market risk (i.e. fall in the value of insurers’ investments), credit risk (e.g. when third parties cannot repay their debts) and operational risk (e.g., risk of systems breaking down or malpractice). These are all risks which are currently not covered by the EU regime. However, experience has shown that all these risk types can pose a material threat to insurers’ solvency. The Solvency II framework was adopted by the European Council and Parliament on 22 April 2009. With respect to ISPVs, Article 209 (*Special purpose vehicle*) establishes that: “1. *Member States shall allow the establishment within their territory of special purpose vehicles, subject to prior supervisory approval. 2. In order to ensure that a harmonised approach is adopted with respect to special purpose vehicles, the Commission shall adopt implementing measures laying down the following: (a) scope of authorisation; (b) mandatory conditions to be included in all contracts issued; (c) the fit and proper requirements as referred to in Article 42 of the persons running the special purpose vehicle; (d) fit and proper requirements for shareholders or members having a qualifying holding in the special purpose vehicle; (e) sound administrative and accounting procedures, adequate internal control mechanisms and risk management requirements; (f) accounting,*

SPVs (or “ISPVs”) into local laws and it enabled domestic regulators to establish a “light touch” authorization and regulatory regime for ISPVs, defined as: “...an undertaking...which assumes risks from insurance...or reinsurance undertakings and which fully funds its exposures to such risks through the proceeds of a debt issuance or some other financing mechanism whereby the rights of the providers of such debt...are subordinated to the undertaking's reinsurance obligations ...”.

According to the RID, ISPVs are not reinsurance undertakings, but they do conduct reinsurance-like activities. The RID expressly requires that an ISPV ‘fully funds’ its insurance risk exposure through the proceeds of financing mechanisms ‘subordinated’ to its reinsurance obligations. While apparently simple, the concept that an ISPV must be “fully funded” is not straightforward and it may give rise to different interpretations, with significant practical impact⁷⁰.

It is important to note that ISPVs established in one EU Member State – and regulated by the authority of such State, according to the *home country control principle* – can assume risks from insurance undertakings established in other Member States and regulated by the authority of such other State. Therefore, Member States that choose not to allow ISPVs to be established within their territories still have to introduce detailed rules setting the conditions for the use of amounts outstanding from an ISPV as assets covering technical provisions (i.e., they must specify to what extent and under what conditions insurance undertakings established in such State are allowed to obtain capital relief for transfers of risks by way of securitisation to ISPVs established in another State). Such rules may be qualitative or quantitative and they may vary across EU jurisdictions, so that harmonisation is not assured in this respect.⁷¹

According to many commentators, one of the main legal impediments to structured finance solutions in the European insurance sector has been the lack of simple transformer structures that ally tax efficiency and flexible regulatory and prudential requirements, whilst allowing for the issue of debt securities and providing reinsurance coverage. Regulators in the EU have either imposed restrictions on these structures or have not recognised that certain transformer structures ought to be regulated in a different way from traditional reinsurance companies. The implementation of the RID should help removing some of the regulatory hurdles that have prevented the insurance industry from fully taking advantage of capital markets. To this purpose, it is useful to provide a brief overview of the RID implementation measures adopted in the U.K. and in France.

In the United Kingdom, as part of the implementation of the RID, the FSA has taken the opportunity to facilitate the creation of a market in the U.K. for insurance special purpose vehicles. Before the RID, an ISPV in the U.K. – as elsewhere in Europe – would have to be authorised, supervised, and indeed taxed, as a full reinsurance company, and would need to maintain a regulatory capital surplus in the same way. The new regime introduced in the U.K. recognises the relatively lower levels of risk associated with the structure of SPV transactions. The authorisation requirements are minimal, with little documentation required that would not already be produced as part of setting up the SPV. Supervision takes place through the

prudential and statistical information requirements; (g) the solvency requirements.” For further information on the Solvency II Directive, see: http://ec.europa.eu/internal_market/insurance/solvency/index_en.htm

oversight of the ceding company, rather than separate supervision of the ISPV. Concerning the solvency requirement for an ISPV, the FSA took the view that the term ‘fully funded’ simply means that the ISPV’s reinsurance liabilities must be capped at the value of the assets available to fund those liabilities.

In France, the implementation of the RID allowed SPVs, established under the form of the ‘*organisme de titrisation*’, to acquire or transfer insurance or reinsurance risks under certain conditions.⁷² The *Autorité de contrôle de l’assurance et des mutuelles* (ACAM) must authorise the establishment of the ISPV, bearing in mind that the rules applicable to such vehicles are designed to result in a much lighter and quicker procedure than that applicable to insurance companies. Under French law, the ISPV is neither an insurance nor a reinsurance undertaking. Furthermore, the law expressly states that the agreements entered into by an ISPV do not qualify as insurance contracts, with all of the related regulatory and tax consequences. ISPVs are not subject to minimum solvency margin or capital requirements, other than that their assets must be equal or greater to their liabilities, meaning that: (i) once the initial funds necessary to cover the ISPVs reinsurance liabilities have been raised in the capital markets, the corresponding proceeds and other assets must remain sufficient throughout the life of the ISPVs to cover the reinsurance risks they bear and (ii) the repayment of the capital markets investors is subordinated to the payments due by the ISPVs to the ceding company (or other insurer creditors) in the event of the materialisation of the underlying insured risks. Moreover, under certain conditions: (i) amounts recoverable from the ISPV by the ceding insurer (or other insurance creditor) may be considered as reinsurance or retrocession in calculating the ceding insurer’s solvency margin requirements and (ii) amounts outstanding from the ISPV may be treated as reducing, or included as assets covering, technical provisions.

Finally, it shall be noted that the future implementation of the Solvency II regime, currently in preparation, is expected to further broaden the scope of admissible risk transfer mechanisms accepted by European regulators, especially for those insurance undertakings that will take advantage of the option to use internal models to assess their solvency capital requirements.⁷³

d) Market transparency and liquidity issues

Industry sources indicated that secondary market activity in CAT bonds has improved in the recent years; however, it is difficult to establish a reliable bond turnover to issuance ratio.

Trading in CAT-linked exchange-traded derivatives has been very low.⁷⁴ Low liquidity in CAT-linked securities may be explained by the absence of a true (electronic) trading platform open to any investor type. The CAT bond market is essentially an OTC market with dealers firms and other investors communicating by

⁷⁴ It is important to learn lessons from the CBOT’s experience in the mid-nineties. While the CBOT offered a trading venue for its CAT-linked futures and options, the rigid membership structure of the exchange created a barrier to entry for the risk cedent (the insurer), leaving the product to be traded among members who may not have had a great expertise or interest in pricing insurance contracts. In addition, the CBOT open outcry trading venue was clearly inappropriate for such products. Some of these problems are alleviated now that derivatives exchanges have demutualised and now offer electronic trading platforms open to all investor types. Yet, the NYMEX and CME derivatives instruments show minimal trading volume. The IFEX futures contracts also show low liquidity, but the presence of two market makers (Deutsche Bank and Swiss Re) may help.

phone or via e-mails. Data providers like Bloomberg or Reuters do not disseminate any price or yield information on CAT bonds. As a result, the CAT-linked securitisation market has suffered from a lack of price transparency.

Transparency in the underlying market is also crucial to secondary market trading. While some sophisticated investors know that insurance companies' historical loss records may not be extremely helpful in understanding and quantifying the risk associated with future catastrophe perils, other investors, including individual investors, value depth and frequency of market information. The lack of standardisation in insurance companies' catastrophe risk exposure records throughout the U.S. industry and the absence of public disclosure of such information may be impairing secondary market trading in CAT-linked securities.

This report has previously noted that (a) only qualified or institutional investors have access to the CAT-linked securities market and (b) only investors with a high level of sophistication are likely to access the CAT-linked securities market and exchange-traded derivatives markets. However, facilitating access to the CAT-linked securities market to retail or individual investors (via secondary market trading or via mutual funds) may raise public policy issues, in light of investor protection objectives embedded in U.S. securities laws and in the recent *Markets in Financial Instruments Directive* in the European Union.

The assessment of risk in CAT-linked securities requires a high level of sophistication and an understanding of the nature and (non) predictability of catastrophe risks. Should catastrophe risk end up in the hands of individual investors whose investment decisions may be based on more traditional risk/return assessment measures than the ones used in CAT risks? Although CAT risks may be uncorrelated with other risks in an investor's portfolio, the nature of these risks makes measurement of the expected rate of return obscure simply because they are difficult to predict. Hence, it becomes difficult for an investor to distinguish an investment from a speculative plunge. The problem can become even more difficult when considering more than one CAT instrument because the nature of the instrument makes risk sensitive to spatial location as well as other characteristics that are not common in diversification decisions. These observations suggest that having an appropriate level of financial education and understanding of CAT risks is a pre-requisite for retail investor access to the CAT-linked securities market.

The current lack of trading activity in exchange-traded derivatives may be better explained by a more fundamental reason: in general, securitisation of markets starts with the development of standardised cash instruments (like CAT bonds). After liquidity occurs, derivatives are designed as tools to hedge exposure to the cash instruments. As noted above, to date there are little signs of standardisation in the CAT-linked security market. Each transaction is unique and cannot be standardised without significant basis risk. Consequently, there is no perfect easy hedging between the cash and derivative markets. This makes trading in the derivatives markets less

⁷⁵ That said, it should be noted that the currently listed derivatives have been designed not as "traditional" tools to hedge price risk, but more like over-the-counter instruments. For instance, IFEX designed its binary options to replicate industry loss warrants. As a result, these contracts may never be heavily traded and their success or failure should be more accurately measured with statistics on open interest rather than on trading volume. Open interest refers to the number of exchange-traded derivatives contracts that are still "open", i.e. number of positions that haven't been liquidated yet.

attractive to potential holders of catastrophe bonds⁷⁵.

5. Recommendations

Based on the analysis in this report, and to the extent that they believe that the growth in CAT-linked securities markets should be encouraged, governments should consider acting, individually and collectively, on the following set of recommendation, namely:

1. ***Promote the collection and dissemination of high-quality data on CAT risks and losses according to harmonised criteria***
 - a. Encourage a greater level of detail and harmonisation in the parametric data collected and made available by national meteorological, seismological, and hydrological agencies on catastrophe events⁷⁶.
 - b. Encourage and sponsor national agencies of meteorology, hydrology, and seismology to install hazard monitoring equipment and recording systems able to capture the parameters of extreme events when they happen, at sufficient density of instrumentation and guarantee of recording that these readings can be employed for developing second-generation parametric trigger structures⁷⁷.
 - c. Encourage a greater level of detail and harmonisation in the collection and dissemination of data concerning insurance market exposure to CAT risks⁷⁸.
 - d. Assist in the creation and fostering of mechanisms to help track insurance industry losses resulting from a catastrophic event.
2. ***Promote transparency in the CAT-linked securities market***
 - a. Promote public dissemination of offerings, prices, triggers, trading volumes and other information concerning transactions in both the primary and the secondary market for CAT-linked securities⁷⁹.

⁷⁶ Such structures, which may help to reduce basis risk, and are able provide settlement for a CAT-linked security within weeks of the occurrence of a catastrophe event would facilitate the expansion of CAT-linked security issuance especially in second tier and developing countries in which it will not be possible, to collect sufficient information on exposures and losses.

⁷⁷ For tropical cyclone in all regions, this data should not only include the central pressure and maximum wind speed of the storm at regular (typically 6 hourly) intervals along the track but also parameters related to the size of the storm. For earthquakes, earthquake maps of strong ground motion (employing strong ground motion data) should be developed as well as intensity maps. For floods, floods maps of the extent, height of flooding, etc. should be developed for all principal areas affected. Standardising these outputs across different agencies would help provide a more universal currency for the exchange of parametric information on catastrophes.

⁷⁸ The gathering, harmonisation, and public dissemination of insurance market exposure data are crucial to quantify basis risk inherent to capital market structures with payouts triggered by an industry loss index. The wider availability of industry insurance data, to the extent that it does not violate proprietary information, will help to bring confidence to using loss indices based on industry losses and also help insurers themselves understand the basis risk between their own losses and those of the whole market.

⁷⁹ Today, both Goldman Sachs and Guy Carpenter keep historical records of CAT bond issuance and details about each offering, but Goldman Sachs' records remains proprietary. Guy Carpenter posts historical information

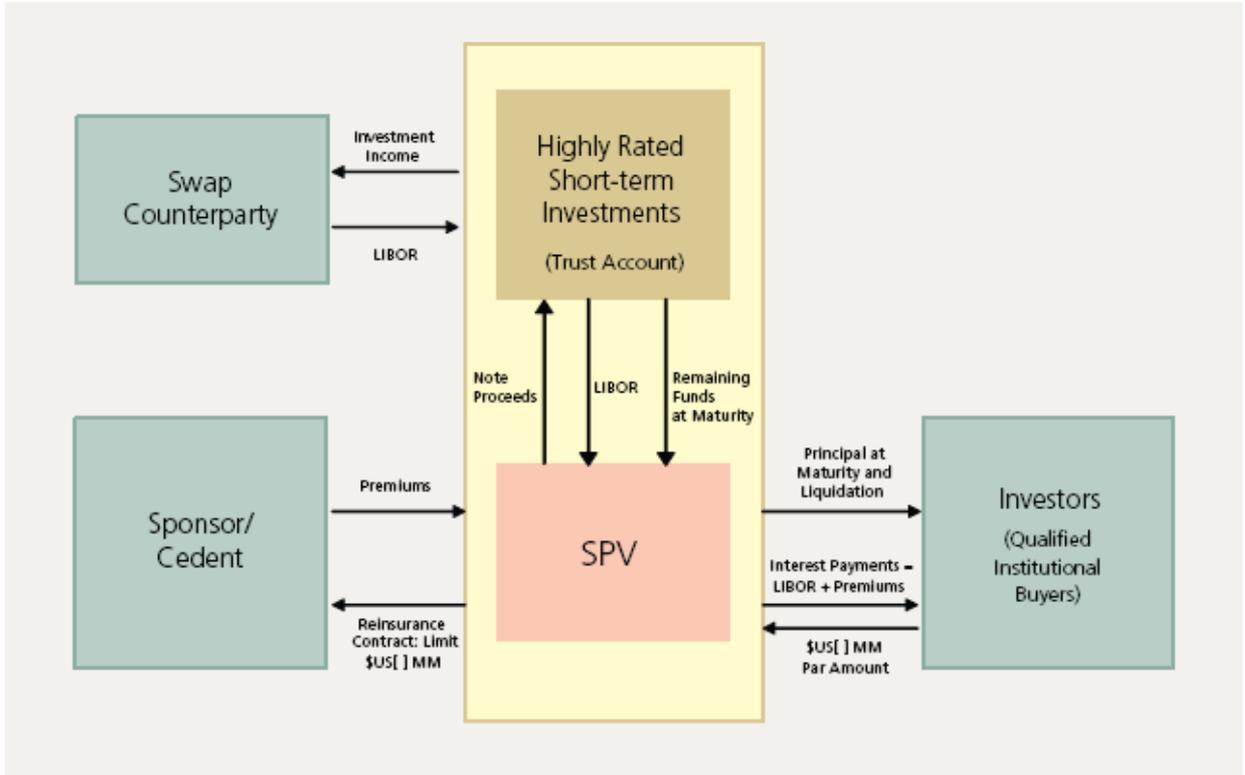
3. ***Consider the opportunity to use CAT-linked securities to transfer a portion of the CAT risk currently borne by governments***
 - a. Governments should examine and assess the appropriateness of using CAT-linked securities to transfer some of their CAT risk to capital markets;
 - b. Based on a cost-benefit analysis, governments of different countries should jointly evaluate the opportunity to securitise pooled risks within a region;
 - c. The evaluation of the costs and benefits of different capital market tools should be preceded by the clear identification of the specific policy objective pursued by the government (e.g., obtaining liquidity for emergency rescue and response measures in the aftermath of a catastrophe, covering the economic losses sustained by public assets and critical infrastructures as a result of a disaster).
4. ***Examine the accounting, solvency and prudential rules presiding over the CAT-linked securities market to remove any unnecessary impediments.***
 - a. The nature and extent of the risk transfer provided by CAT-linked securities must be carefully examined and assessed, in accordance with the principle of substance over form. Comparable levels of capital relief should, in principle, be allowed for comparable levels of risk transfer, irrespective of the legal form of the transaction and the amount of capital relief should reflect the amount of risk transferred.
 - b. The differences between an ISPV participating in a CAT-linked securities transaction and a traditional reinsurance undertaking should be clearly recognized and reflected in the applicable regulatory and solvency regime.
5. ***Encourage research on areas worthy of further investigation.***
 - a. The role of CAT-linked securities as diversification tools in asset portfolios requires more study. Further research is warranted as the market has greatly developed in the recent years, providing additional yield and return statistics. The impact of moral hazard on pricing indemnity-triggered CAT bonds, the quantification of basis risk in CAT-linked capital market structures, and the trade-off between basis risk and moral hazard all require further investigation. For instance, developing a methodology on how to structure CAT-linked securities in order reduce both basis risk and moral hazard would be valuable.
 - b. The development of securities to hedge basis risk should be studied. To date, in non-indemnity based CAT-linked securities, very few market participants are willing to take the basis risk away from the sponsor. Research on this topic may be valuable to firms seeking a “niche” in the CAT-linked securities market.
6. ***Encourage further education on CAT-linked securities.***
 - a. The demand and supply in the CAT-linked securities market depend on the education of potential investors and sponsors. The acquisition of the requisite education, i.e., knowledge to participate, in the market is one of the most

on catastrophe bond issuance on its website, with some details on each offering, but does not provide price or trigger information.

important barriers to entry and so to growth.

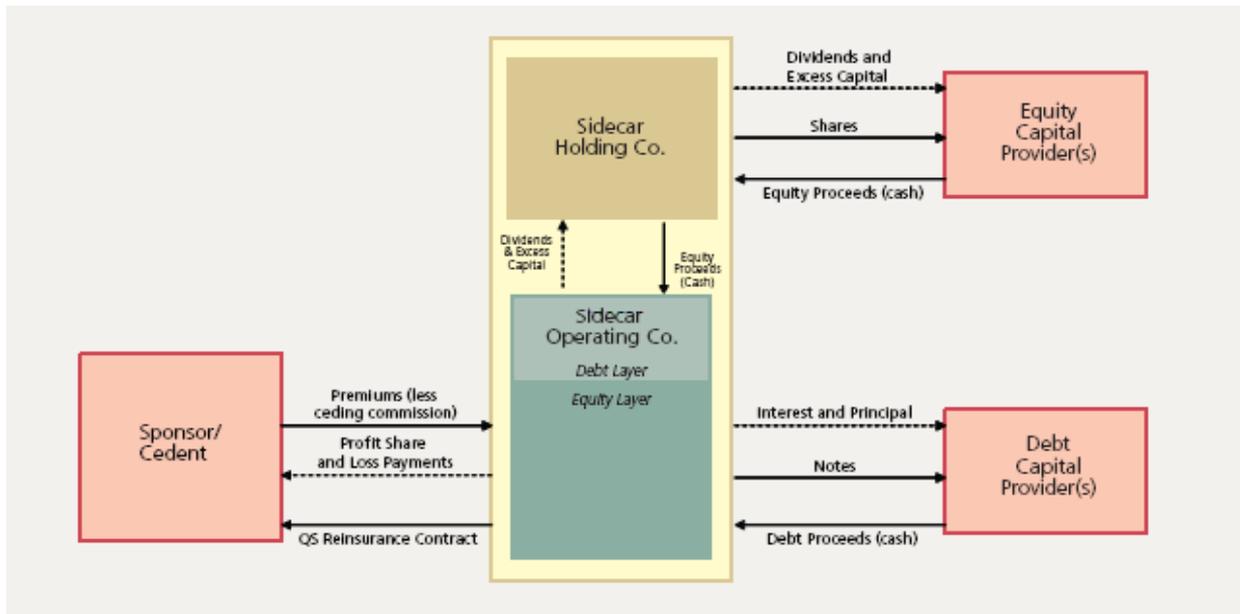
- b. An understanding of the CAT-linked securities market by governments and regulators is necessary for the establishment of an appropriate legal, regulatory, and tax framework for these securities.

ANNEX 1: STRUCTURE OF A CAT BOND



Source: The Catastrophe Bond Market at Year-End 2006, Guy Carpenter & Company, LLC

ANNEX 2: STRUCTURE OF A SIDECAR



Source: The Catastrophe Bond Market at Year-End 2006, Guy Carpenter & Company, LLC

MAIN REFERENCES

- (2006). BBA Credit Derivatives Report. British Bankers Association, BBA Enterprises Ltd.
- (2006). "A New Plateau for the U.S. Securitisation Market." FDIC Outlook (Fall): 3-9.
- (2008). Research Quarterly, SIFMA. 111.
- (2008). "Weather Market Shows Robust 35% Increase in Trades for 2007-2008", Weather Risk Management Association, 4 June 2008.
- Bouriaux, S. (2001). "Basis Risk, Credit Risk and Collateralization Issues for Insurance-linked Derivatives and Securities." *Journal of Insurance Regulation* 20: 94-120.
- Cox, S. H., H. W. Pedersen, et al. (2000). "Catastrophe Risk Bonds." *North American Actuarial Journal* 4(4): 56-82.
- Cummins, J. D. and P. M. Danzon (1997). "Price Shocks and Capital flows in Liability Insurance." *Journal of Financial Intermediation* 6: 3-38.
- Cummins, J. D. and J. F. Outreville (1987). "An International Analysis of Underwriting Cycles in Property-Liability Insurance." *Journal of Risk and Insurance* 54(2): 246-62.
- Elul, R. (2005). The Economics of Asset Securitisation. Federal Reserve Bank of Philadelphia. Q3: 18-25.
- Froot, K. A., B. S. Murphy, et al. (1995). The Emerging Asset Class: Insurance Risk, Guy Carpenter.
- Froot, K. A. and S. Posner (2000). Issues in The Pricing of Catastrophe Risk, Marsh & McLennan Securities Special Report.
- Froot, K. A., D. S. Scharfstein, et al. (1993). "Risk Management: Coordinating Corporate Investment and Financing Policies." *Journal of Finance* 48(5): 1629-58.
- Garven, J. R. and R. D. MacMinn (1993). "The Underinvestment Problem, Bond Covenants and Insurance." *Journal of Risk and Insurance* 60(4): 635-646.
- Harrington, S. and G. Niehaus (1999). "Basis Risk with PCS Catastrophe Insurance Derivative Contracts." *Journal of Risk and Insurance* 66(1): 49-82.
- Heike, D. and J. Kiernan (2002). Improving Portfolio Performance with Catastrophe Bonds. Alternative Risk Strategies. M. Lane. London, Risk Books: 545-556.
- Helfenstein, R. and T. Holzheu (2006). "Securitisation - new opportunities for insurers and investors." *Sigma* 7.
- Kroszner, R. S. (2007). Recent Innovations in Credit Markets. Credit Markets Symposium. Charlotte Branch of the Federal Reserve Bank of Richmond, Charlotte, North Carolina.

- Lai, G. C., R. C. Witt, et al. (2000). "Great (and not so Great) Expectations: An Endogenous Economic Explication of Insurance Cycles and Liability Crises." *Journal of Risk and Insurance* 67(4): 617-652.
- Lane, M. N. and R. G. Beckwith (2007). That was the Year that was! The 2007 Review of the Insurance Securitisation Market. Trade Notes.
- Litzenberger, R. H., D. R. Beaglehole, et al. (1996). "Assessing Catastrophe-Reinsurance Linked Securities as a new Asset Class." *Journal of Portfolio Management*: 76-86.
- MacMinn, R. D. (1984). "A General Diversification Theorem." *Journal of Finance* 39(2): 541-50.
- MacMinn, R. D. (2005). *The Fisher Model and Financial Markets*. Singapore, World Scientific Publishing.
- Major, J. A. (1999). *Index Hedge Performance: Insurer Market Penetration and Basis Risk. The Financing of Catastrophe Risk*. K. A. Froot. Chicago and London, University of Chicago Press: 391-426.
- Mengle, D. (2007). *Credit Derivatives: An Overview*. Financial Markets Conference. Federal Reserve Bank of Atlanta.
- Rosen, R. J. (2007). *The Role of Securitisation in Mortgage Lending*. Chicago Fed Letter, Federal Reserve Bank of Chicago: 244.
- Samuelson, P. A. (1967). "General Proof That Diversification Pays." *Journal of Financial and Quantitative Analysis* 2(2): 1-13.
- Vaugirard, V. E. (2003). "Pricing Catastrophe Bonds by an Arbitrage Approach." *Quarterly Review of Economics and Finance* 43(1): 119-32.
- Winter, R. A. (1994). "The Dynamics of Competitive Insurance Markets." *Journal of Financial Intermediation* 3(4): 379-415.