Capital Market Instruments for Natural Catastrophe and Terrorism Risks: A Bright Future?

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Editors' Summary

Natural catastrophes and terrorism risks are more threatening than ever. Associated damages increase yearly, and traditional compensation solutions have shown their limitations. Capital markets have been hailed as the new solution for dealing with these catastrophes, but the current financial crisis has cast a doubt on their potential. However, a number of capital market instruments are proving resilient to the crisis, due to the decorrelation of insurance and financial risks and to their general attractiveness in comparison with other forms of securitization. Is there a future for capital market instruments to complement or partially replace traditional compensation mechanisms?

Although natural catastrophes and terrorist attacks have a low probability of occurrence, when they do occur the consequences can be of high severity, affecting a large number of persons as well as their property. For many individuals and enterprises, insurance is one of the most practical and effective ways of handling the damages caused by such a major event. Through insurance, individuals and enterprises spread risks so that no single entity receives a financial burden it cannot cope with. But catastrophic losses present special problems for insurers because large numbers of insured parties may incur losses at the same time. A surge of insurer defaults and dramatic changes in capacity and pricing may follow in the aftermath of a catastrophe. Devastating natural or man-made catastrophes can lead to a wave of financial catastrophes.

One way to deal with these catastrophe risks is through reinsurance. First, reinsurance supports insurance companies to underwrite large risks, limit liability on specific risks, increase capacity, and share liability when claims overwhelm the primary insurer's resources.[1] However, in the case of extremely large or multiple catastrophic events, insurers might not have purchased sufficient reinsurance, or reinsurance providers might not have sufficient capital to meet their existing obligations.[2] In any event, after a catastrophic loss, reinsurance capacity may be diminished and reinsurers might limit availability of future catastrophic reinsurance coverage, while, on the other hand, the demand of potential victims increases.[3] It is generally known that reinsurance is influenced by price cycles, which are particularly pronounced in catastrophe insurance.[4] Given this cyclic nature of the reinsurance market, investors have incentives to look for alternative capital sources.

The most straightforward way for (re)insurance companies to raise capital in the capital market is to issue company stock. However, holding extra capital by insurers includes both benefits and costs. The benefits of additional capital comprehend higher premium prices by making their promise to pay claims credible to policyholders, avoidance of loss of franchise value that could occur if the insurer is financially threatened from a catastrophe, and a reduction in foregone investment opportunities. However, the additional agency

1. Matthew Rodermund sees four important reinsurance goals: financing, creating stabilization, creating capacity, and catastrophe protection. *See* Matthew Rodermund, *Four Points of Confusion About Reinsurance: Comment*, 32 J. Risk & Ins. 133, 133-36 (1965). *See also* George E. Rejda, Principles of Risk Management and Insurance 520 (6th ed. 1998).
2. See especially the numerous contributions by Kenneth Froot, Kenneth A. Froot, *Introduction*, *in* Nat'l Bureau of Econ. Research, The Financing of Catastrophe Risk 1 (Kenneth A. Froot ed., 1999) [hereinafter Financing of Catastrophe Risk]; Kenneth A. Froot & Paul G.J. O'Connell, *The Pricing of U.S. Catastrophe Reinsurance*, *in* Financing of Catastrophe Risk, *supra*, at 195.
3. Anne Gron, *Insurer Demand for Catastrophe Reinsurance*, *in* Financing of Catastrophe Risk, *supra* note 2, at 23.
4. On the cyclic nature of reinsurance markets, see Peter Zimmerli, Swiss Re, Natural Catastrophes, and Reinsurance (2003).

and tax costs associated with holding more capital limit the amount of capital held by insurers and can have a large effect on the price of catastrophe coverage. Moreover, any investor in an insurance company's stock is subject to the risks of the entire company. Therefore, an investor's decision to purchase stock will depend on an assessment of the insurance company's management, quality of operations, and overall risk exposures from all perils.

Consequently, additional solutions need to be sought. One very attractive option is capital market instruments. These instruments can face risks associated with the insurance company's underwriting standards but do not take on the risk of the overall insurance company's operations. However, the current financial crisis has cast some doubt on their potential to deliver adequate financial capacity to the insurance sector. Hence, this Article will examine closely this mechanism and will determine whether the financial crisis has indeed reduced its "bright future."

I. Alternative Risk Transfer

A. *Introduction to Alternative Risk Transfer*

Alternative Risk Transfer (ART) is an extremely pliable concept that has no precise definition.[5] It generally describes a range of solutions that can assist insurance companies and other corporations in the financial management of their business by drawing upon methodologies from the insurance and banking sectors. Initially, ART primarily referred to mechanisms for corporations to insure their own risks by means of captives, risk retention groups, pools, etc. More recently, the concept has acquired a broader scope and includes all forms of risk transfer and risk financing solutions—except for traditional insurance and reinsurance—which are able to spread risks over time and within the policyholder's portfolio (multi-line and multi-year cover). As a result, ART is used to absorb the effects of a hard market or to manage complex or difficult risk exposures, which are often uninsurable in the traditional insurance market.

Banks defines the ART market as the "combined risk management marketplace for innovative insurance and capital market solutions," while ART is "a product, channel or solution that transfers risk exposures between the insurance and capital markets to achieve stated risk management goals."[6] A product is "any instrument or structure that is used to achieve a defined risk management goal," and include select insurance/reinsurance products, multi-risk products, insurance-linked capital market issues, contingent capital structures, and insurance derivatives. Vehicles are "any channel that is used to achieve risk management goals," and include captives and risk retention groups, special purpose vehicles[7] reinsurers, Bermuda transformers, and capital market subsidiaries. Finally, solutions are "any broad program that uses multiple instruments or vehicles to manage risk exposures on a consolidated basis," and include enterprise risk management programs.

Swiss Re classifies the ART market into two categories: "risk carriers" and "solutions."[8] There are basically four types of alternative risk carriers: self-insurance and captives, pools, risk retention groups, and the capital markets.[9] The alternative solutions consist of finite risk (re)insurance, contingent capital, multi-year/multi-line products, multi-trigger products, new asset risk solutions, weather derivatives, and securitization/insurance-linked securities.

Whichever classification is made, the ART market can be identified by six key features:

- tailor-made solutions;
- multi-dimensional coverage: multi-year and/or multi-line cover;
- substitution of pure risk transfer with risk financing, facilitating the insurance of traditionally uninsurable risks;
- often contains some form of risk transfer of non-insurance risk;
- incorporation of financial tools, such as derivatives; and
- inclusion of a large component of finance.

5. For an excellent and clear overview of Alternative Risk Transfer, see Erik Banks, Alternative Risk Transfer: Integrated Risk Management Through Insurance, Reinsurance, and the Capital Markets (2004).
6. *Id.* at 49.
7. An increasingly important "special purpose vehicle" formed by insurance and reinsurance companies to provide additional capital to write reinsurance, usually for property catastrophe risks, is the innovative vehicle known as "sidecars." Sidecars are relatively simple agreements that allow a reinsurer to transfer to another reinsurer or group of investors, such as hedge funds, a limited and specific risk, such as the risk of an earthquake or hurricane in a given geographic area over a specific period of time. Sidecars are typically privately owned, allowing them to further define their risk/business relationship with the existing company from which they are ceding risk. They generally have limited lifetimes to capitalize on high prices in hard markets and quickly withdraw capacity in soft markets. The sidecars receive premiums for the reinsurance underwritten and are liable to pay claims under the terms of the reinsurance contracts. In addition to providing capacity, sidecars also enable the sponsoring reinsurer to move some of its risks off balance sheet, thus improving leverage. *See* Michael Butt, *Insurance, Finance, Solvency II, and Financial Market Interaction*, 32 Geneva Papers on Risk & Ins. 42; J. David Cummins, *Reinsurance for Natural and Man-Made Catastrophes in the United States: Current State of the Market and Regulatory Reforms*, 10 Risk Mgmt. & Ins. Rev. 179, 197-99 (2007).
8. *The Picture of ART*, Sigma (Swiss Re, Zurich, Switz.), Issue No. 1/2003, at 16.
9. The various alternative risk carriers, except risk retention groups (which are U.S.-specific liability carriers based on mutually shared interests), will be discussed in the following sections.

B. ART Market Participants

The ART market tries to consider risk management by matching the demand of particular services with the supply.[10] Corporations and insurance companies, for example, need risk solutions that can protect their financial capacity, minimize financial distress, and help to maximize their enterprise value. Investors, on the other hand, demand capital deployment opportunities with returns that reflect the risk taken. If such opportunities can be identified successfully, they will supply the marketplace with risk capital. Intermediaries bridge the gap between the corporations and insurance companies, and the investors by creating solutions and delivering risk capacity.

Although large non-financial corporations increasingly ask for risk transfer solutions—given the increasing array of risks such as earthquakes, terrorism, financial volatility, weather volatility, and so on—this Article will primarily focus on those ART instruments that are used by insurance and reinsurance companies.

C. The Future of ART

It is likely that the ART market will continue to grow. The following factors will most probably lead to the growth of the alternative risk market[11]:

- the volatility of the traditional insurance market resulted in the withdrawal of capacity in this market following catastrophe events;
- the high cost of traditional reinsurance following a catastrophic event encourages cedants to find other means of risk financing. The cedant will prefer to exploit the traditional insurance market when rates are soft but use ART solutions when rates harden;
- capacity for large natural catastrophes in the traditional (re)insurance market is lacking; and
- the convergence between banking, insurance, and securities markets is being encouraged by greater emphasis on the efficient use of capital and subsequent risk diversification.

To conclude, the foregoing indeed suggest that the ART marketplace can be considered "alternative" because it pierces the boundaries of traditional risk management concepts and techniques, e.g., pure reinsurance, insurance, and derivatives, calling on diverse financial engineering mechanisms from a number of different sectors and drawing in capital from a broad range of sources.

10. For more information, see Banks, *supra* note 5, at 52-58.
11. *See European Commission ART Market Study: Final Report*, at 9-10, Study Contract ETD/99/B5-3000/C/51 (Oct. 2, 2000), *available at* http://ec.europa.eu/internal_market/insurance/docs/studies/risk_en.pdf (last visited Dec. 16, 2009).

II. Capital Market Instruments

A. Introduction

The capital markets are the fourth type of alternative risk carriers—apart from self-insurance and captives, risk retention groups, and pools. Capital market instruments form a significant component of the ART market and are becoming indispensable to cover catastrophe risks. Actually, it is said that insurance and reinsurance markets provide catastrophe risk coverage and that capital markets add financial capacity (to both the (re)insurance industry and other corporations, although only the first option is to be considered in the following section).

Although there are various ways of defining and categorizing capital market instruments, a division into three segments has been chosen for the remainder of this Article: (1) securitization and insurance-linked securities, (2) contingent capital structures, and (3) insurance derivatives.[12] This section will briefly define these three classes, while the following sections will provide more detail, especially in the light of catastrophe coverage. It is not my intention to be exhaustive, but merely to give more insight into the functioning and the possibilities of various capital market instruments for adding financial capacity to the catastrophe (re)insurance industry.[13]

B. Securitization and Insurance-Linked Securities

The first segment of capital market instruments is securitization and insurance-linked securities. Securitization is a financing technique that allows "the packaging of designated pools of loans or receivables with an appropriate level of credit enhancement and the redistribution of these packages to investors. Investors buy the repackaged assets in the form of securities or loans which are collateralized (secured) on the underlying pool and its associated income stream. Securitization thereby converts illiquid assets into liquid assets."[14] Securitization is, in other words, "the process of removing assets, liabilities, or cash flows from the corporate balance sheet and conveying them to third parties through tradable securities."[15]

Given past successes with pure financial securitization, banks took their securitization technologies to the insurance market in the 1990s, and so-called insurance-linked securities

12. This classification follows Erik Banks in Banks, *supra* note 5, at 115.
13. Some financial instruments are derived from traditional reinsurance, and will not be discussed. For example, sidecars are relatively simple agreements that allow a reinsurer to transfer to another reinsurer or group of investors, such as hedge funds, a limited and specific risk, such as the risk of an earthquake or hurricane in a given geographic area over a specific period of time. *See* Butt, *supra* note 7. Also so-called industry loss warranties (ILWs) used to have a traditional reinsurance form, but have now been developed further into instruments where the reinsurer pays a portion of the primary company's losses according to an agreed upon formula and which are triggered by an agreed-upon industry loss. *See* Ali Ishaq, *Reinsuring for Catastrophes Through Industry Loss Warranties—A Practical Approach*, Casualty Actuarial Soc'y F., Spring 2005, at 75.
14. Mark Fisher & Zoe Shaw, Securitisation: For Issuers, Arrangers, and Investors (2003).
15. Banks, *supra* note 5, at 115.

(ILS) were born.[16] ILS are financial instruments which transfer insurance-related risks directly to institutional investors in the capital markets.[17] They serve two primary purposes: to manage and hedge insurance risks, and to increase capital efficiency by drawing on alternative sources of financing.

C. Contingent Capital

Another category of capital market instruments is contingent capital. Contingent capital is a relatively new type of convergence product, connecting insurance and capital markets, but its use should be considered as an excellent element of post-loss funding. Contingent capital is based on a contractual commitment to provide capital to a company, i.e., an insurance company, after a specific adverse event occurs that causes financial distress (defined as the trigger). Unlike insurance-linked securities, which contain aspects of insurance/reinsurance and securities, contingent capital facilities are structured strictly as funding/banking facilities or securities transactions, with no element of insurance contracting. The economic motivation of the insured corporation is to have access to less expensive capital than it could obtain through capital markets or bank loans after the occurrence of the trigger event. The corporation that purchases the contingent capital option has the right to sell its own securities at a preset price for a fixed period of time, after the specified event has occurred. Contingent debt and contingent equity are the two most popular contingent capital structures and stand for any post-loss debt respectively equity financing made available when specific events are triggered.

D. Insurance Derivatives

The last and third segment of capital market products and services are derivatives, broadly defined as financial instruments whose value depends upon a market reference or a risk factor, such as the performance of assets, interest rates, currency exchange rates, or indices; the price of a bond, commodity, currency or share; weather data, such as inches of rainfall or heating degree days; insurance data, such as claims paid for a disastrous earthquake or flood; etc. Since the scope of financial derivatives is broad, only those derivatives used to manage insurance-related risks (so-called insurance derivatives) will be considered in this Article.[18] Moreover, the focus of the ART-related derivatives business lies also primarily on traditional insurance risks.

After having discussed and defined the three classes of capital market instruments, the following sections will focus on each instrument separately and on their possible link to natural catastrophes. More insight will be given on the role of capital markets in catastrophe risk coverage.

III. Insurance-Linked Securities

A. Standard Structure

While Insurance-Linked Securities (ILS)[19] structures have been refined and customized in recent years, the basic architecture has remained relatively unchanged: an insurance or reinsurance company (or a corporation) issues securities or bonds through a so-called Special Purpose Vehicle (SPV) and bases repayment of interest on the occurrence or severity of losses arising from defined insured events. If losses exceed a predetermined threshold, the insurer/reinsurer is no longer required to pay investors interest and/or principal. Through this elemental structure, new risk supply is created: the issuer passes a defined exposure to capital market investors, lowering its risk profile. This provides capital and reserve relief and allows new business to be written.

The market for insurance-linked securities includes catastrophe bonds, weather bonds, life securitization bonds, and residual value securities, but this Article will only touch upon catastrophe bonds.

B. Benefits and Costs of Insurance-Linked Securities

Insurance securitization benefits various parties, including issuing companies, investors, and intermediaries. During a hard reinsurance market, the issuing or ceding company (generally an insurer) can—besides reinsurance—make use of this loss-financing mechanism to manage risk. Moreover, since the insurer's risks are repackaged into notes and sold to investors via the special purpose vehicle, the ceding insurer no longer needs to be concerned about specific performance by the reinsurer; this reduces the insurer's credit exposure. Also, investors gain by purchasing securities that are likely to have little or no correlation with other risk assets in their portfolios, i.e., there is no so-called credit risk. As a consequence, ILS could enhance a portfolio's risk-reward profile.[20] Furthermore, the covered catastrophic events are not otherwise traded in the securities markets, which makes securities based on catastrophic property non-redundant.

The benefits of insurance-linked securities, however, also go accompanied by certain costs and disadvantages. Creating the ILS structure can be relatively expensive, based on costs associated with forming SPVs, preparing documentation, engaging investment banks to underwrite the issue (although they do not have contractual or business relationships with

16. The idea of securitizing insurance risk was first suggested in Robert Goshay & Richard Sandor, *An Inquiry Into the Feasibility of a Reinsurance Futures Market*, J. Bus. Fin., Vol. 5, Issue 2, at 56 (1973).
17. It should be noted that J. David Cummins makes a division between Alternative Risk Transfer and insurance-linked securities: "ART products do not expand the available capital base very much beyond existing insurance and reinsurance markets, whereas insurance-linked securities enable hedgers potentially to access the entire global capital market." J. David Cummins, *Convergence in Wholesale Financial Services: Reinsurance and Investment Banking*, 30 Geneva Papers Risk & Ins. 187, 199 (2005).
18. However, "credit derivatives" will be discussed in the small section on capital market instruments and terrorism risk, *infra*.
19. "Mortality-linked securities," which are the securitization of portfolios of life insurance or annuity policies, will not be discussed. For more on mortality-linked securities, see Yijia Lin & Samuel H. Cox, *Securitization of Catastrophe Mortality Risks*, 42 Ins.: Mathematics & Econ. 628 (2008).
20. *See* Samuel H. Cox & Hal W. Pedersen, *Catastrophe Risk Bonds*, N. Am. Actuarial J., Vol. 4, Issue 4, at 56.

the insurance company receiving coverage), performing the analytic work in assessing and pricing the securities, and so on. Further, the illiquidity of the marketplace and the lack of good hedging instruments for intermediaries that might otherwise be willing to make markets, constitute other disadvantages to the creation of ILS. Enhanced standardization and liquidity will hence be crucial for the success of insurance securitization.[21] Insurance-linked securities are thus only justifiable in the cost/benefit framework when other loss-financing alternatives are more expensive.

C. Triggers

Every insurance-linked security has a trigger that determines the conditions under which the ceding company can suspend interest and/or principal payments (either temporarily or permanently). In general, a trigger may be based on single or multiple events and becomes effective after a cedant's losses exceed a particular amount. Triggers can take three different forms: the indemnity trigger, the index trigger, and the parametric trigger. Each version has its own characteristics, advantages, and disadvantages. Regardless of the trigger type, most bonds are structured with an initial deductible, e.g., first loss retention by the issuer, and caps, e.g., maximum payout or protection by investors to the issuer.

Indemnity triggers are based on an issuer's actual exposure to a particular predefined event. Since the cedant knows that the ILS trigger is based on actual losses, he might not be very diligent in underwriting risks or enforcing loss control behavior. While most of the earliest bonds in the market featured indemnity triggers, a gradual shift towards parametric and index triggers has occurred since the turn of the millennium.[22]

Parametric triggers are based on the occurrence of a catastrophic event with one or more certain defined physical parameters, such as location and intensity, e.g., for an earthquake this can be the location of the epicenter and the magnitude of the event, for a hurricane it may be the location of landfall and the minimum central pressure or average sustained wind speed. Parametric structures focus primarily on event location and intensity rather than structural vulnerabilities.

The last form of triggers is the index trigger. Index triggers are based on a recognized industry loss index. In practice, industry losses can be derived from granular property databases, including number of risks, value by type, occupancy, coverage, and business. Since index transactions add transparency and do not require a full evaluation of the cedant's underlying risk portfolio, they are mostly favored by many investors.

D. Catastrophe Bonds

Catastrophe bonds (also called cat bonds or Act of God bonds) came into existence due to the lack of capacity in the catastrophe reinsurance market.[23] They represent a form of insurance securitization in which risk is transferred to investors rather than to insurers or reinsurers. Typically, an insurer or reinsurer will issue a cat bond to investors (such as life insurers, hedge funds, or pension funds), and when a pre-specified event occurs prior to the maturity of the bond, the investors risk losing the accrued interest and/or the principal value of the bonds.

1. Standard Structure

The catastrophe bonds are structured similarly to traditional ILS, with an important exception: if a pre-specified event such as a hurricane occurs prior to the maturity of the bonds, then investors risk losing accrued interest and/or the principal value of the bonds. Specifically, a catastrophe bond offering is made through a special purpose reinsurer (SPR), an issuance vehicle that may be an insurance or a reinsurance company.[24] The SPR provides reinsurance to a sponsoring insurance or reinsurance company and is backed by securities issued to investors. More specifically, the special purpose reinsurer sells notes to investors, passes the proceeds to the trustee for further reinvestment, and provides an indemnity contract to the issuing company. The return generated

21. De Mey distinguishes eight specific impediments to securitization: legal issues, contract standardization, data and modeling, risk disclosure, lack of appropriate indices, transaction costs, rating caps and recourse. Cummins on the other hand sees the relative abundance of capital in the reinsurance industry, insurer unfamiliarity, uncertainties about the regulatory, tax and accounting treatment, the lack of fully satisfactory indices that can be used to trigger payments under the contracts, the lack of development of a liquid secondary market, the lack of a widely accepted pricing model, and the infrequency of catastrophic events as possible impediments for the success of insurance-linked securities. *See* Cummins, *supra* note 17; Jozef De Mey, *Insurance and the Capital Markets*, 32 Geneva Papers Risk & Ins. 35 (2007).

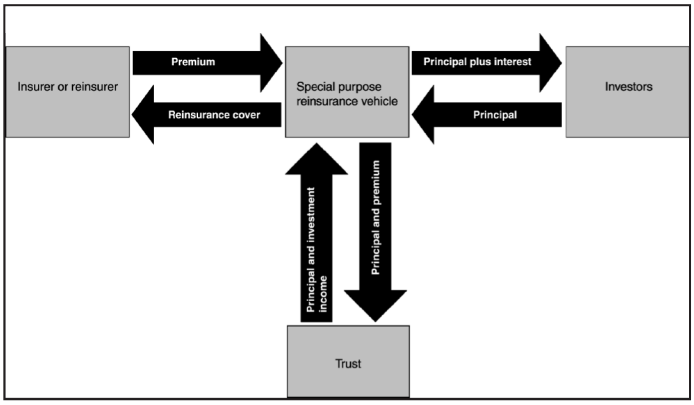
22. Peter Carayannopoulos et al., Inst. for Catastrophic Loss Reduction, Insurance Securitization: Catastrophic Event Exposure and the Role of Insurance-Linked Securities in Addressing Risk 4 (2003); Guy Carpenter LLC, The Growing Appetite for Catastrophe Risk: The Catastrophe Bond Market at Year-End 2004, at 6 (2005) [hereinafter Guy Carpenter 2004]. However, Guy Carpenter notes that, since 2007, the perceptions regarding indemnity triggers continue to evolve, leading to a possible resurgence of indemnity triggers. *See* Guy Carpenter LLC, The Catastrophe Bond Market at Year-End 2007: The Market Goes Mainstream 15-18 (2008) [hereinafter Guy Carpenter 2007].

23. For more information on catastrophe bonds, see, for example, Francis Parisi & H. Herlihy, Standard & Poor's, Modeling Catastrophe Reinsurance Risk: Implications for the CAT Bond Market (1999); U.S. Gov't Accountability Office (GAO), Publ'n No. GAO-03-1033, Catastrophe Insurance Risks: Status of Efforts to Securitize Natural Catastrophe and Terrorism Risk (2003) [hereinafter GAO 2003]; U.S. GAO, Publ'n No. GAO-02-941, Catastrophe Insurance Risks: The Role of Risk-Linked Securities and Factors Affecting Their Use (2002) [hereinafter GAO 2002]; Vivek J. Bantwal & Howard C. Kunreuther, *A Cat Bond Premium Puzzle?*, 1 J. Psychol. & Fin. Markets 76 (2000); Cox & Pedersen, *supra* note 20; Jin-Ping Lee & Min-Teh Yu, *Pricing Default-Risky CAT Bonds With Moral Hazard and Basis Risk*, 69 J. Risk & Ins. 25 (2002); Joanne Linnerooth-Bayer & Aniello Amendola, *Global Change Natural Disasters and Loss-Sharing: Issues of Efficiency and Equity*, 25 Geneva Papers Risk & Ins. 203 (2000); Martin Nell & Andreas Richter, *Improving Risk Allocation Through Indexed Cat Bonds*, 29 Geneva Papers Risk & Ins. 183 (2004) [hereinafter Nell & Richter, *Improving Risk Allocation*]; Greg Niehaus, *The Allocation of Catastrophe Risk*, 26 J. Banking & Fin. 585 (2002); Martin Nell & Andreas Richter, Catastrophe Index-Linked Securities and Reinsurance as Substitutes (Goethe Univ. Frankfurt, Working Paper Series: Finance & Accounting, August 2000) [hereinafter Nell & Richter, Working Paper], *available at* http://www.finance.uni-frankfurt.de/wp/582.pdf; Angelika Schöchlin, *Where's the Cat Going? Some Observations on Catastrophe Bonds*, J. Applied Corp. Fin., Winter 2002, at 100; Pascal Pensa, CatBonds (Universität Basel, Working Paper No. 06-04, 2004) (in German).

24. SPRs are usually established offshore—typically in Bermuda or the Cayman Islands—to take advantage of lower minimum required levels of capital, favorable tax treatments, and a generally reduced level of regulatory scrutiny, as compared to the United States, where catastrophe bonds have been developed.

through reinvestment and the premium payment from the issuing company form the investor coupon that becomes due and payable on a periodic basis. The invested proceeds held in the trust account are used to repay principal at maturity. If a named catastrophic event occurs, the trustee will withhold interest and/or principal payments temporarily or permanently. Principal that otherwise would be returned to the investors is then used to fund the SPR's payments to the insurer. The investor's reward for taking catastrophe risk is a relatively high interest rate paid by the bonds. Since the issuing company will be exposed to losses on its underlying catastrophe risk but will no longer need to provide payments to investors, it has effectively used the capital markets investor base to hedge its risk.

The following figure may help understand the structure of catastrophe bonds:



GAO (2002). Catastrophe Insurance Risks. The Role of Risk-Linked Securities. Statement of Davi M. D'Agostino, Director, Financial Markets and Community Investment. Testimony Before the Subcommittee on Oversight and Investigations, Committee on Financial Services, House of Representatives. GAO-03-195T. Washington D.C., 3.

2. Catastrophes Covered[25]

Hurricane Andrew in 1992, causing damage in the northwestern Bahamas, southern Florida, south of Miami, and south-central Louisiana, and with a damage cost totaling $26 billion in 1992, and the Northridge Earthquake on January 17, 1994, in the city of Los Angeles, with total damage estimated at $15 billion, spurred the development of catastrophe bonds in the United States. Though catastrophe bonds can theoretically be issued on many hazards, they are in practice centered on natural catastrophes, and more specifically on earthquake, hurricane, and windstorm. However, the scope of coverage and regional coverage is expanding steadily, with new covers already available on perils such as hailstorm, windstorm, and terror-related events, and for countries such as France, Germany, Japan, and Taiwan.

Although catastrophe bonds have been used primarily as an alternative to catastrophe reinsurance, there are also examples of corporations and other non-insurance entities[26] issuing cat bonds. For example, during the summer of 1999, Tokyo Disneyland issued cat bonds because its management found at the time that it was cheaper to have the capital markets insure its earthquake exposure than the insurance markets. More recently, the Fédération Internationale de Football Association (FIFA) issued a $260 million cat bond to protect itself against a terrorism-related cancellation of the 2006 World Cup in Germany. Terrorism-related bonds are thus beginning to enter the market. Interestingly, such bonds did not appear in the immediate aftermath of 9/11, despite the obvious shortage of terrorism-related risk capacity. Several fundamental reasons have been posited for this lack of activity, including reputational concerns associated with issuing a security linked to potentially tragic human events, strong correlation between a terrorist attack and the global equity markets, pricing uncertainties/modeling challenges, and potential moral hazard problems.

3. Advantages and Disadvantages of Catastrophe Bonds

Catastrophe bonds serve an extremely useful role in their overall approach to manage natural catastrophe risk exposures and are therefore a complement to several other basic risk management tools: they raise more equity capital by selling more company stock, they limit risks through the underwriting and asset management process, and they allow a reinsurance company to transfer a portion of its natural catastrophe exposures to the capital markets rather than retaining the exposure on its books of business or retroceding the risks to other reinsurers.[27] Moreover, those insurance companies who are not able to obtain for the low-probability, high-severity class of risks the necessary amount of reinsurance can now benefit from catastrophe bonds in this risk category. Consequently, cat bonds have a moderating effect on reinsurance prices and prevent reinsurance prices from increasing any faster than they did.[28] Furthermore, investing in catastrophe bonds could be recommended since cat bonds have presumably low or zero correlation with other currently traded assets and are therefore a promising instrument for portfolio enhancement.[29] In addition, cat bonds have attractive risk/return characteristics, especially for those large, sophisticated investors they are designed for, such as mutual funds/investment advisors, proprietary/hedge funds, and (re)insurers.[30] Investments in catastrophe risk indeed are proven to over-perform domestic bonds and

25. *See* Erik Banks, Catastrophic Risk: Analysis and Management 117-18 (2005).

26. In 2006, the Mexican government issued an earthquake bond to help it pay for losses in the event of a devastating quake. This is the first time a sovereign state has issued such a bond.

27. GAO 2003, *supra* note 23, at 19.

28. *Id.* at 20.

29. Robert H. Litzenberger et al., *Assessing Catastrophe Reinsurance-Linked Securities as a New Asset Class*, J. Portfolio Mgmt., Winter 1996, at 76.

30. Angelika Schöchlin, On the Market Price of Catastrophic Insurance Risk: Empirical Evidence From Catastrophe Bonds (2002) (unpublished Ph.D. dissertation, Universität St. Gallen).

returns on catastrophe bonds are proven to be less volatile than either stocks or bonds.[31]

However, in practice and according to various voices in the insurance and reinsurance business, as recorded by the U.S. Government Accountability Office it seems that catastrophe bonds are struggling with significantly high costs, especially compared to the costs of buying traditional reinsurance coverage. One of the costs associated with catastrophe bonds is the interest costs that insurers must pay to compensate investors for purchasing securities that involve a substantial risk of loss of principal. Administrative and transaction costs are cited as another reason for the relatively high costs associated with catastrophe bonds. Transaction costs indeed represent approximately 2% of the total coverage provided by a catastrophe bond (for example, $2 million for a security providing $100 million in coverage). These costs include: underwriting fees charged by investment banks, fees charged by modeling firms to develop models to predict the frequency and severity of the event that is covered by the security, fees charged by the rating agencies to assign a rating to the securities, and legal fees associated with preparing the provisions of the security and preparing disclosures for investors. The price of a reinsurance contract would not typically include such additional fees. As a result, most institutions have in practice limited their investments in catastrophe bonds to no more than 3% of their total portfolios.[32] Others even avoid purchasing catastrophe bonds altogether because of their perceived risks or because it would not be cost-effective for them to develop the technical capacity to analyze the risks of securities so different from the securities in which they currently invested.

Although the costs or disadvantages associated with catastrophe bonds, as seen above, seem far stronger than the potential benefits, the analysis of the costs associated with cat bonds can also be questioned. Indeed, catastrophe bonds may be cost-competitive with traditional reinsurance for high-severity and low-probability risks, for retrocessional coverage, and for larger sized transactions.[33] Further, insurers tend to undervalue the risk that —due to credit deterioration—reinsurers might not be able to honor their reinsurance contracts if a natural catastrophe were to occur.[34] Also, various provisions in reinsurance contracts—such as deductibles, termination clauses, and reinstatement premiums—may also raise their costs and should be factored into the cost comparison between catastrophe bonds and reinsurance costs. Finally, Vivek Bantwal and Howard Kunreuther have proven that ambiguity aversion, myopic loss aversion, and fixed costs of education can also account for the reluctance of institutional investors to enter the catastrophe bond market. An additional factor may be worry over the impact of a catastrophic loss on the performance of the cat bonds. According to the authors, potential investors should be able to overcome these obstacles after they are comfortable with both the complexity and the uncertainty of the cat bond market. Issuers can address the former by standardizing a simple structure of terms so that an investor's fixed cost of education on their first cat bond will not require them to incur additional high costs when evaluating future issues. Quantifying and reducing pricing uncertainty can help investors overcome their aversion to ambiguity.[35] It can therefore at least be concluded that there exist mixed views on the purchase of catastrophe bonds.

4. Future Prospects for Catastrophe Bonds

Although the catastrophe bond market is still relatively small compared with the traditional insurance and reinsurance markets, it is expected to continue to grow and exert an important check and balance upon pricing and underwriting practices in traditional insurance and reinsurance markets.[36] Indeed, catastrophe bonds have already become an increasingly important, if not yet dominant, part of the loss-financing market, supplementing solutions from the (re)insurance and public sectors.[37] Since the launch of the first catastrophe bond in 1994, more than 116 issues covering $22.3 billion of risk have been arranged at the end of 2007.[38] Of this total, 52% ($11.7 billion) have been issued in 2006-2007 alone. Annual issuance has been steady to impressive, averaging approximately 27 new deals with transfer capacity up to $7 billion in 2007. Over 85% of these catastrophe-linked securities are sold in the United States, which is, apart from being the largest market, the market with the clearest tendency for financial innovations.[39]

It should, however, be noted that a worldwide financial meltdown affected the (re)insurance industry deeply in 2007-2008. More particularly, access to capital tightened in 2007-2008, making capital markets less attractive to (re)insurers. Nonetheless, the catastrophe bond performances held up rather well in 2008 (apart from a shut down in September), as catastrophe bonds are claimed not to be correlated with broader credit markets.[40] In fact, investors searched for investment products entailing high returns on their investment during the credit crisis, and the demand for catastrophe bonds was even likely to increase: the promise of a return of more than 15% in case of no catastrophes can make catastrophe bonds irresistible.[41] Since catastrophe bonds did demon-

31. *See* Kenneth A. Froot et al., Guy Carpenter LLC, The Emerging Asset Class: Insurance Risk (1995).
32. Whether a 2% transaction cost may completely explain why institutional investors limit their exposure is, however, doubtful. It is more likely that this result is jointly a function of sensible asset allocation and limited supply.
33. Martin Nell and Andreas Richter indeed argue that catastrophe bonds have presumably lower transaction costs compared to reinsurance. Insurance coverage indeed usually incurs costs of acquisition, monitoring, and loss adjustment, all of which can be reduced by making use of the financial markets. *See* Nell & Richter, *supra* note 23.
34. GAO 2003, *supra* note 23, at 22.
35. *See* Bantwal & Kunreuther, *supra* note 23.
36. Ironically, the growth of the catastrophe bond market is in turn fueling the growth prospects of the reinsurance industry, as a number of hedge funds that were early cat bond investors are now starting to launch their own reinsurance firms.
37. See also the prospects for and concerns regarding cat bonds in Pensa, *supra* note 23.
38. Guy Carpenter 2007, *supra* note 22, at 4.
39. Schöchlin, *supra* note 23, at 104.
40. David Priebe, *A Defining Year for Cat Bonds*, Reinsurance Mag., Jan.-Feb. 2009, at 8. *See also* Guy Carpenter 2007, *supra* note 22, at 33-36.
41. SD/IDW (June 2, 2008). Verdien geld aan rampen, *available at* http://www.m24.be. (in Dutch).

strate their resilience during the so-called credit crisis, their likely importance for the coming years can be indicated. And indeed, the cat bond market rebounded in 2009, with $725 billion in bonds issued through March 30, 2009. The 2009 cat bond issuance volume has been pushed past $3 billion, which exceeds the $2.8 billion raised in 2008, but still be less than the record issuance of $7 billion for 2007.[42] 2010 promises a strong cat bond market due to the increase in cat bonds issued and the decrease in price. Yet, the expectation of lower reinsurance rates could leave the insurance and reinsurance industry with less reason to turn to cat bonds.[43]

IV. Contingent Capital

A. *Standard Structure*

A contingent capital arrangement is a form of prearranged financing provided to a company after it experiences a financially stressful event. Financing is thus arranged on an ex ante basis, providing a company with a capital infusion on an ex post basis. The company pays a capital commitment fee to the party that agrees in advance to purchase debt or equity following a loss. If no catastrophic event (this is the triggering event) occurs, then a company has no need for additional capital and the facility remains unused.

The terms and conditions of contingent capital financing can be highly tailored and can thus vary widely: loans can be fixed or floating rate, securities can be issued as common equity, debt, or preferreds, structural provisions could include payment deferral mechanisms, conversion options, maturity extension features, and other elements designed to enhance a company's financial flexibility and infuse liquidity, etc. Like the catastrophe bond triggers noted above, contingent capital triggers can be designed on an indemnity basis in order to match a company's exposure to a specific loss-making event, or they can be based on transparent market indices.

Contingent capital can be structured in various forms, but generally, two broad classes are considered[44]: contingent debt and contingent equity—which stand for any post-loss debt respectively equity financing made available when specific events are triggered—together with their individual subclasses: contingent debt facilities,[45] contingent surplus notes,[46] catastrophe equity put options,[47] and put protected equity.[48]

B. *Benefits and Costs of Contingent Capital*

Contingent capital arrangements are especially suitable for hedging against extremely rare, but severe loss events, such as natural catastrophes. With a contingent capital arrangement, the company does not transfer its risk of loss to investors. Instead, after a loss occurs, it receives a capital injection in the form of debt or equity to help it pay for the loss. Because the terms of the capital injection are preagreed to, the company generally receives more favorable terms than it would receive if it were to raise capital after a large loss, when it is likely to be in a weakened financial condition. If no catastrophic event occurs, then a company has no need for additional capital and the facility remains unused. Under these conditions, contingent capital can provide a cost-efficient solution, aiming at the prevention of insolvency and at the prevention of a threat to planned investment projects due to a lack of disposable funds.[49] Additionally, contingent capital structures can address risks that are unhedgeable or cannot be adequately mitigated with traditional capital markets tools. Moreover, potential tax deductibility from ongoing interest payments if debt funding is used can be seen as another benefit of contingent capital use. On the other hand, contingent

42. Colleen McCarthy, *New Structures Revive Market for Cat Bonds*, Bus. Ins., Mar. 30, 2009, at 43; Tom Johansmeyer, *Cat Bond Market Pushes Past $3 Billion*, Daily Finance, Dec. 21, 2009.
43. Tom Johansmeyer, *The "Catastrophe Bond" Market Is Heading to a Surprisingly Healthy 2009*, Daily Finance, Dec. 8, 2009.
44. Banks, *supra* note 25, at 126-31.
45. "Contingent debt facilities" are available as "committed capital facilities" and "contingency loans." A committed capital facility (CCF) is funded capital that is arranged prior to a catastrophic loss, and which is accessible only when two trigger events are breached. The first trigger on a CCF is often implicit—that is, the financing option will not be exercised unless it has value, and it will only have value if a loss occurs and the company cannot obtain cheaper funding from other sources. The second trigger is generally related to the exposure that can create a loss requiring funding. On the other hand, there is the "contingency loan," which is a variant of the CCF. The contingency loan is a bank of line of credit that is arranged in advance of a loss and invoked when a trigger event occurs.
46. "Contingent surplus notes (CSNs)" are another form of contingent debt financing. Surplus notes in themselves are notes sold to investors that are counted as policyholders' surplus (equity) rather than as a liability (debt) on an insurer's statutory balance sheet. They represent borrowings by an insurer for which no liability is recorded on the firm's balance sheet. A benefit of surplus notes is that they increase an insurer's assets, and thus its capacity to write business, without increasing its liabilities. CSNs, then, are prearranged so that an insurer has the option to immediately obtain funds by issuing surplus notes at a pre-agreed-to rate of interest. Without this arrangement, after a large loss, the insurer might find it difficult to issue surplus notes on favorable terms. An insurer can use the funds to bolster its surplus following a loss. However, a known disadvantage of CSNs relates to the fact that investors are still subject to the general business risk of the insurance company. For more information, see Michael W. Elliott, *Contingent Capital Arrangements*, Risk Mgmt. Q., Sept. 2001, at 1.
47. The most notable example of a contingent equity structure is the "catastrophe equity put option," also called "catastrophe equity put (CatEPut)." A catastrophe equity put option is a right to sell equity (stock) at a predetermined price in the event of a catastrophic loss. The CatEPut thus results in the issuance of new shares if a predefined trigger, namely a catastrophic event, is breached. The purchaser of a CatEPut pays a commitment fee to the seller, who agrees to purchase the equity at a pre-agreed-to price in the event of a catastrophic loss, as defined in the put agreement. To reduce the possibility of moral hazard arising from an indemnity structure, CatEPuts often contain two triggers. The first trigger may be based on the company's stock price, and the second trigger can relate to a specific catastrophic loss that must be sustained in order for exercise to occur. A major advantage of CatEPuts is that they make equity funds available at a pre-agreed-to price when a company needs them the most: immediately following a catastrophe. Moreover, the costs of a CatEPut can compare quite favorably to a standard reinsurance contract because the option purchaser must remain financially viable in order to claim access to funding. A disadvantage of CatEPuts is that they dilute ownership in the organization following a loss. The amount of equity increases when the put option is exercised, thereby reducing the existing shareholders' percentage of ownership.
48. "Put protected equity (PPE)" is a second form of contingent equity. PPE is a mechanism where a company buys a put on its own equity in order to generate an economic gain should the value of its stock decline in the aftermath of a loss.
49. *Alternative Risk Transfer (ART) for Corporations: A Passing Fashion or Risk Management for the 21st Century?*, Sigma (Swiss Re, Zurich, Switz.), Issue No. 2/1999, at 27-28.

capital agreements also incur costs, including payment of an upfront, non-refundable fee to secure financing that may never be required. Relevant is here whether this fee is fairly priced. A cost-benefit analysis hence has to be made.

V. Catastrophe Derivatives

A. *Standard Structure*

The general class of insurance derivative contracts can be divided into two distinct groups, which are distinguished by the way they are traded in the market: exchange-traded (or listed) derivatives and over-the-counter (OTC) derivative contracts. The former are the standardized derivative contracts, traded through an authorized exchange (either physical or electronic) with the exchanger or its clearinghouse acting as intermediary on every contract, subject to standard margin requirements and clearing rules. Futures,[50] options,[51] and futures options[52] comprise the primary types of listed contracts. OTC derivatives, on the other hand, are bespoke derivative contracts that are traded (and privately negotiated) directly and informally between two parties rather than via a formal exchange or other intermediary. Popular OTC derivatives include swaps,[53] forwards,[54] options, and credit derivatives.[55] Both types of derivative contracts provide the holder with an optionable interest and can be used to hedge, speculate, or arbitrage. The fact that derivatives can be used to generate a profit distinguishes them from insurance contracts, which are based on an insurable interest and cannot be used to generate speculative profit. When used as hedges, they are essentially loss-financing mechanisms and thus of interest for this research.

Catastrophe derivatives, financial contracts whose value depends upon the occurrence of a catastrophic event, were introduced in the capital markets as recently as the 1990s. They are only in a nascent state of development and yet have to make significant penetration in the risk management sector, just like catastrophe bonds and contingent capital.[56]

B. *Benefits and Costs of Catastrophe Derivatives*

Derivatives provide several key benefits that make them an important part of the loss-financing process.[57] The main gain from derivatives is that they make it possible to hedge risks that otherwise would be unhedgeable. Risks are born by those who are in the best position to bear them and individuals and companies can take on riskier but more profitable projects by hedging those risks that can be hedged. Derivates can indeed neutralize the downside effects of a single risk, diversify a portfolio of exposures (and in so doing, reduce risk), and provide capacity to engage in additional risk-related business. As a result, the economy is more productive and welfare is higher. In addition to their risk sharing properties, derivatives markets facilitate information gathering in the presence of frictions and market incompleteness. For example, in a number of countries, the only reliable information about long-term interest rates is obtained from swaps because the swaps market is more liquid and more active than the bond market. Other important benefits of derivatives include the following: some derivative contracts are quite liquid and can serve as cost-effective risk solutions, transactions arranged through the OTC market are highly customizable, insurable interest and proof of loss do not have to be demonstrated (generating a speculative gain is a perfectly acceptable end goal), delays in receiving payment in the event a contract pays off are minimal, and financial payments to the party holding the in-the-money contract are generally not capped.[58]

However, although derivatives can make underlying markets more efficient, observers have long been concerned that they can also disrupt markets because they make it easier to build speculative positions. The above benefits are thus contrasted with the risks stemming from derivatives' trading activities.[59] Further, other costs or disadvantages regarding derivatives include the following: coverage of non-standard risks through the exchange-traded market is very limited, liquidity for contracts on non-standard risks is minimal, derivatives are perceived as a risky business, and certain bilateral contracts expose a firm to downside payments. Also, derivatives can create risk at the firm level, especially if a firm uses derivatives episodically and is inexperienced in their use. And for the economy as a whole, derivatives may create systemic risks when a market participant becomes excessively large relative to particular derivatives markets.

50. A "future" is a standardized, transferable, exchange-traded contract that represents an obligation to buy or sell a specific quantity of an underlying asset, at a price agreed but not exchanged on trade date, for settlement at a future time.
51. An "option" is a contract that gives the purchaser the right, but not the obligation, to buy ("call option") or sell ("put option") the underlying reference asset at a set price (known as a strike price) at any time until an agreed expiry date (American option) or on the expiry date (European option).
52. A "futures option" is an option on a futures contract, thus giving the purchaser the right to enter into an underlying futures transaction in exchange for a premium. A futures put gives the purchaser the right to sell a futures contract at a set strike price, while a futures call gives the purchaser the right to buy a futures contract at a set strike price.
53. A "swap" is a bilateral transaction calling for periodic, e.g., annual, semi-annual, quarterly, exchange of payments between two parties based on a defined reference index, and can be regarded as a package of forward contracts. In short, a swap is an agreement to exchange one set of cash flows for another according to specified terms.
54. A "forward" is a customized, bilateral, single period contract referencing a specific market/asset reference. Like a futures contract, it represents an obligation to buy or sell a specific quantity of an underlying reference asset at a price agreed but not exchanged on trade date, for a settlement in the future. Unlike a futures contract, no intervening cash flows are exchanged.
55. A "credit derivative" is an OTC derivative designed to transfer credit risk from one party to another. By synthetically creating or eliminating credit exposures, they allow institutions to more effectively manage credit risks.
56. Scott Harrington asks the question whether catastrophe derivatives can fundamentally change the insurance business in Scott E. Harrington, *Insurance Derivatives, Tax Policy, and the Future of the Insurance Industry*, 64 J. Risk & Ins. 719 (1997).
57. *See* Banks, *supra* note 25, at 135-36; Rene M. Stulz, *Should We Fear Derivatives?*, J. Econ. Persp., Summer 2004, at 173.
58. *See also* Roger Laeven, *Issues Around Catastrophe Derivatives*, AENORM, July 2002, at 4, *available at* http://www.aenorm.eu/artikelen/36-laeven.pdf (discussing the prerequisites for catastrophe derivatives for being an effective alternative to traditional reinsurance).
59. Consequently, a new categorization of these risks has been proposed that distinguishes between explicit (market) risks and the ones stemming from the informational and functional characteristics of a given financial market structure.

Overall, Stulz[60] concludes that the benefits of derivatives outweigh the potential threats, but Scott Harrington, Steven Mann, and Greg Niehaus[61] warn that insurance derivatives can only be viable if they are able to lower insurers' costs compared to other methods that mitigate the effects of correlated risk, such as holding additional equity capital and purchasing reinsurance.[62]

C. Exchange-Traded Catastrophe Derivatives

1. Chicago Board of Trade

The earliest attempt at introducing securities based on natural disasters dates back to the end of 1992, when the Chicago Board of Trade (CBOT), one of Chicago's three listed derivative exchanges, developed catastrophe futures and call-spread options.[63] Protection was thereby provided to cover a percentage of natural disaster losses occurring in layers of exposure for all events within the six-month contract period. Futures and options were available for four geographic regions. Initially, loss payouts were based on an index created by the Insurance Services Office (ISO). The ISO index was a compilation of catastrophe loss ratio data gathered from more than 100 participating companies, representing 23% of the property insurance industry. The reliability of these indices, however, became a concern when they did not accurately reflect industry losses resulting from the Northridge Earthquake on January 17, 1994.[64] As a result, both contracts were unable to generate any meaningful activity and were abandoned shortly thereafter.

After identifying the flaws and potentials for enhancements, the CBOT created in September 1995 catastrophe insurance options[65] based on the more widely used Property Claims Services (PCS) indices of incurred disaster losses. The PCS cat insurance options (or CBOT catastrophe options) offered the advantage of standardized contracts with low transaction costs traded over an exchange. Specifically, the purchaser of a catastrophe option paid the seller a premium, and the seller provided the purchaser with a cash payment if an index measuring catastrophe losses exceeded a certain level. If the catastrophe loss index remained below a specified level for the prescribed time period, the option expired worthless, and the seller kept the premium. The option might have been purchased by an insurance company that wanted to hedge its catastrophe risk and might have been sold by firms that would do well in the event of a catastrophe—for example, homebuilders—or by investors looking for a chance to diversify outside of traditional securities markets. Buyers could simultaneously buy and sell call options with different strike values to create a desired coverage layer.[66] However, trading in CBOT catastrophe options ceased in 1999 due to lower-than-expected demand and due to their inability to make it a truly alternative to other catastrophe risk solutions. They were abandoned in 2000.

2. Catastrophe Risk Exchange

To remedy this problem, a second exchange called the Catastrophe Risk Exchange (CATEX) became operational on October 1, 1996.[67] CATEX, based in New York, is essentially an electronic bulletin board system on which insurance companies (CATEX subscribers) can anonymously list risks that they are eager to cede (under a traditional insurance treaty format) or to swap against other risks (reinsurance swap transaction). However, in contrast to the trading with insurance derivatives on the CBOT, there is no direct flow of additional capacity from the financial markets into the insurance industry through the CATEX exchange. Although it generated a lot of interest, the CATEX failed to live up to expectations as most exposures were actually swapped between the related parties rather than on the system. It did however demonstrate that interest exists for a cat risk swap market.

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60. *See* Stulz, *supra* note 57.
61. *See* Scott E. Harrington et al., *Insurer Capital Structure Decisions and the Viability of Insurance Derivatives*, 62 J. Risk & Ins. 483 (1995).
62. *See also* Thomas F. Siems, *10 Myths About Financial Derivatives* (Cato Inst., Cato Policy Analysis No. 283, Sept. 11, 1997), *available at* http://www.cato.org/pubs/pas/pa-283.html. These 10 myths are, according to Thomas Siems, the following: (1) derivatives are new, complex, high-tech financial products created by Wall Street's rocket scientists; (2) derivatives are purely speculative, highly leveraged instruments; (3) the enormous size of the financial derivatives market dwarfs bank capital, thereby making derivatives trading an unsafe and unsound banking practice; (4) only large multinational corporations and large banks have a purpose for using derivatives; (5) financial derivatives are simply the latest risk-management fad; (6) derivatives take money out of productive processes and never put anything back; (7) only risk-seeking organizations should use derivatives; (8) the risks associated with financial derivatives are new and unknown; (9) derivatives link market participants more tightly together, thereby increasing systemic risks; and (10) because of the risks associated with derivatives, banking regulators should ban their use by any institution covered by federal deposit insurance. Siems consequently concludes:
> Derivatives allow for the efficient transfer of financial risks and can help to ensure that value-enhancing opportunities will not be ignored . . . . Derivatives also have a dark side . . . . Users should be certain that the proper safeguards are built into trading practices and that appropriate incentives are in place so that corporate traders do not take unnecessary risks.
63. *See, e.g.*, Banks, *supra* note 25, at 139-40; GAO 2002, *supra* note 23; Christopher M. Lewis & Peter O. Davis, *Capital Market Instruments for Financing Catastrophe Risk: New Directions?*, 17 J. Ins. Reg. 110 (1998); Niehaus, *supra* note 23. For a more detailed discussion of the CBOT futures and options markets, see Stephen P. D'Arcy et al., *Pricing Catastrophe Risk: Could Cat Futures Have Coped With Andrew?* (Cas. Actuarial Soc'y, Discussion Paper Program, 1999); Stephen P. D'Arcy & Virginia Grace France, *Catastrophe Futures: A Better Hedge for Insurers*, 59 J. Risk & Ins. 575 (1992); Greg Niehaus & Steven V. Mann, *The Trading of Underwriting Risk: An Analysis of Insurance Futures Contracts and Reinsurance*, 59 J. Risk & Ins. 601 (1992); J. David Cummins & Helyette Geman, *Pricing Catastrophe Insurance Futures and Call Spreads: An Arbitrage Approach*, J. Fixed Income, March 1995, at 46.
64. Michael S. Canter et al., *Insurance Derivatives: A New Asset Class for the Capital Markets and a New Hedging Tool for the Insurance Industry*, J. Applied Corp. Fin., Fall 1997, at 69.
65. The futures contracts were abandoned. Only options were traded.
66. For example, with each index point representing $100 million in aggregated market losses, an 80/100 call-spread option provides coverage for the layer of losses from $8 billion to $10 billion.
67. CATEX has not been technically designated as an exchange, but as a reinsurance intermediary by the New York Department of Insurance. Under New York law, CATEX can not allow capital market firms, such as banks, dealers, hedge funds, or "transformer" firms to access the system. However, this finally changed, as CATEX, in a joint venture with the Bermuda Stock Exchange, started operations in Bermuda.

3. Bermuda Commodities Exchange

The interest in the PCS index options and CATEX has led to the development of other exchanges and other contracts. Perhaps the most notable is the Bermuda Commodities Exchange (BCE), established in spring 1997 as a disaster swap market for catastrophe risk based on Guy Carpenter's catastrophe index (GCCI). The GCCI monitors sample insurer catastrophic losses resulting from atmospheric peril, meaning that it tracks only the damages that policyholders claim from windstorms, hail, and freezing. There are two obvious disadvantages to such an index. First, it ignores the damages incurred by uninsured asset holders, thus not accounting for the full effect of a disaster. Second, it completely ignores damage from fire, earthquakes, or floods, not allowing complete catastrophe risk transfer. The index was chosen, however, because it is calculated geographically according to the relevant U.S. postal (ZIP) code. Though considerable planning and effort went into the development phase, the exchange was unable to gain sufficient support from the reinsurance industry, and the BCE project was ultimately abandoned.

D. OTC Catastrophe Derivatives

It is no surprise that the OTC market is more flexible than the formal exchange market, and thus the most innovative in developing new insurance derivatives. In fact, the ability to customize deals has made the over-the-counter derivatives market a more liquid forum for managing catastrophe insurance risks. This section will consider catastrophe swaps,[68] pure catastrophe swaps, and weather derivatives. Of course, other variations on the theme are possible.

1. Catastrophe Swap

Some (re)insurers manage their catastrophe risk portfolios using the catastrophe swap. This is a contract whereby an insurer agrees to make periodic payments to another party, e.g., a reinsurer,[69] and the other party agrees to make payments to the insurer that are based on the occurrence of catastrophe losses. In the standard catastrophe swap, the investor receives his or her premium up front and, depending on his or her credit rating, may use a letter of credit to guarantee his obligation. If the named event occurs and creates a loss, the investor provides the ceding swap party with compensation and assumes the claim rights through subrogation. If it does not occur, the transaction terminates, with the insurer's portfolio remaining unchanged.

The catastrophe swap creates risk capacity for the insurer by transferring a portion of its catastrophe portfolio to the reinsurer. In this sense the swap is the financial equivalent of a reinsurance contract or of securitization, but it avoids the structural complexities and costs associated with facultative agreements or full catastrophe bond issuance. However, an insurer with a small catastrophe exposure would almost certainly not arrange a swap, opting instead for a standard reinsurance contract with premium deductibility features and a familiar contractual and legal framework.

2. Pure Catastrophe Swap

In some instances (re)insurers prefer to alter their portfolios through another important type of OTC catastrophe derivatives: the pure catastrophe swap.[70] The pure catastrophe swap is, according to Banks, a manmade reciprocal transaction that allows companies and institutions to exchange uncorrelated catastrophe exposures from existing portfolios. Since the risks being swapped are uncorrelated, participating insurers can achieve greater portfolio diversification, reducing their overall levels of risk exposure. Thus, if an insurer has a concentrated book of business in a catastrophe-prone area, he can swap a portion of that business for a book of business in an area where it is less exposed to the same risk. Both insuring parties can also gain exposure to perils that they may not be able to access directly. For instance, a Japanese insurer with an excess of Japanese earthquake risk may wish to reduce its concentrations by swapping a portion of its portfolio for an uncorrelated risk, such as a European windstorm; a French insurer, actively writing European windstorm risk, may wish to diversify its own portfolio and agrees to accept Japanese earthquake exposure in exchange for a portion of its European windstorm portfolio. If a Japanese earthquake strikes and creates losses under the original insurance contracts, the loss payment obligations become the responsibility of the French insurer rather than the Japanese insurer as a result of the swap. In practice the Japanese insurer will make claims payments to its cedants and will then expect to receive the same amount as restitution from the French insurer under the terms of the agreement. In some cases a swap might involve the exchange of multiple, but still uncorrelated, perils, such as California earthquake for a combination of Monaco earthquake, Japanese typhoon, and European windstorm. The end result of this series of exchanges is greater portfolio balance for the two insurers, arranged on a relatively quick and cost-effective basis.

3. Weather Derivatives

Another important derivatives contract belonging under the heading of over-the-counter derivatives is weather derivatives.[71] Weather derivatives are a relatively recent kind of

68. As a reminder, a swap is a bilateral transaction calling for periodic, e.g., annual, semi-annual, quarterly, exchange of payments between two parties based on a defined reference index, and can be regarded as a package of forward contracts. In short, a swap is an agreement to exchange one set of cash flows for another according to specified terms.

69. This is called the "catastrophe reinsurance swap," as denominated in Banks, *supra* note 25, at 140-42.

70. *Id.*

71. The number of contributions on weather derivatives is noticeably increasing. For more detailed information, see Patrick L. Brockett et al., *Weather Derivatives and Weather Risk Management*, 8 Risk Mgmt. & Ins. Rev. 127 (2005); Sean D. Campbell & Francis X. Diebold, *Weather Forecasting for Weather Derivatives*, 100 J. Am. Stat. Ass'n 6 (2005); Lixin Zeng, *Weather Derivatives and Weather Insurance: Concept, Application, and Analysis*, 81 Bull. Am. Meteorological Soc'y 2075 (2000); Lixing Zeng, *Pricing Weather Derivatives*, 1 J.

financial product developed to hedge weather risks and the fast[72] development of weather derivatives represents one of the recent trends towards the convergence of finance and insurance. Weather risks are the uncertainty in cash flows and earnings caused by non-catastrophic weather events, such as temperature, humidity, rainfall, snowfall, stream flow, and wind. They are contrasted with the catastrophe-related risks caused by, among others, hurricanes, tornadoes and windstorms. However, since it is not an easy task to draw a clear line between catastrophic and non-catastrophic events, e.g., heavy rainfall can cause a catastrophe, it seems obvious to discuss shortly weather derivatives in this manuscript.

Until recently, insurance has been the main tool used by companies for protection against unexpected weather conditions. But insurance does little to protect against the reduced demand that businesses experience as a result of weather that is warmer or colder than expected. Therefore, weather derivatives have been introduced. A weather derivative is a contract between two parties that are adversely affected by unanticipated weather swings (such as the energy and power industry, agriculture, insurance, tourism and retail businesses), stipulating how payment will be exchanged between these parties depending on certain meteorological conditions during the contract period. OTC weather derivatives are usually structured as call/put options and swaps based on different underlying weather indices. Because the choice of the weather index is extremely flexible, weather derivatives can be structured to meet a wide variety of risk management needs.

E. Challenges for Catastrophe Derivatives

As can be concluded from the above, the catastrophe derivatives market is at present still in an underdeveloped stage, partly because it only started to develop in the beginning of the 1990s. Its potential as a useful catastrophe risk management tool can, however, not yet be approached, since catastrophe derivatives still face various challenges that have to be resolved by direct participants and other stakeholders before further expansion can occur.[73] These challenges include the following[74]: (1) until the exchange-traded sector can identify catastrophe indices that more precisely match the needs of end-users and intermediaries, basis risk will continue to plague contract design; a potential is for exchanges and intermediaries to use the same index triggers that are most commonly used for the key perils securitized through catastrophe bonds, (2) lack of contract transparency, (3) difficulties in locating the risk-taking side of the transactions, (4) pricing difficulties, and (5) regulatory barriers that limit the type of business certain regulated entities can conduct.

VI. A Comparative Analysis of Capital Market Instruments

The capital market instruments, as described above, are plentiful. However, considerable differences exist regarding their use for catastrophic risks—some financial instruments are hardly known—and their geographical spread is almost limited to the United States—even Europe is only starting to get interested in the option of going to the capital markets to manage catastrophe risks. A strict description of the various capital market instruments cannot completely satisfy in this paper: it is hardly possible to find the most efficient capital market instrument to manage catastrophe risks just by knowing of their existence. Therefore, this section will try to compare the financial instruments on different grounds, thereby giving more insight in their advantages and disadvantages.

A. Liquidity Risk, Basis Risk, Moral Hazard and Adverse Selection, and Credit Risk

All financial instruments that hedge catastrophe risks enable insurers to reduce that risk by passing it on to investors, who take positions on the occurrence and costs of catastrophes. Each instrument has distinct investment risk characteristics and their design determines which participants bear which type of investment risk. A comparison of various capital market instruments can hence be made on the basis of the several types of investment risk[75]: liquidity risk, basis risk, moral hazard, adverse selection, and credit risk.[76]

Liquidity risk refers to the risk that an investor is not able to trade quickly enough at prices that reflect current market demand and supply conditions. Basis risk occurs when cash flows from the hedging instrument do not exactly offset cash flows from the instrument being hedged. Basis risk thus arises when the counterparty's payments are based not on the insurer's claim payments but on an industry average. Moral hazard exists when the buyers of catastrophe securities can not accurately monitor whether the insurers are properly managing the catastrophic risks in their policies. Adverse selection may exist if the insurance companies alone know the true risk of their policies and if hedging prices reflect the average risk of all policies. Under these conditions, high-risk insurance companies may have a particular incentive to trade catastrophe financial instruments. Credit risk, finally, arises when the ceded firm is unable to pay its obligation to the ceding firm.

Insurance-linked securities managing catastrophe risks have initially been structured to pay off on three types of

Risk Fin. 72 (Spring 2000); Geoffrey Considine, Aquila Energy, Introduction to Weather Derivatives, http://www.cmegroup.com/trading/weather/files/WEA_intro_to_weather_der.pdf (last visited Dec. 17, 2009).

72. *See, e.g.*, CME Group, Weather Products Homepage, http://www.cmegroup.com/trading/weather/index.html (last visited Dec. 17, 2009).

73. It is, however, worth stressing that the catastrophe derivatives will never become as widely used as other financial derivatives, as the core size of the catastrophe risk transfer market is much smaller than that of interest rates, currencies, equities, and credits.

74. *See* Banks, *supra* note 25, at 144-46.

75. Of course, the contract period, the number of risks covered, the degree of standardization, and the possibility of access to the capital markets are also features that can be taken into account.

76. *See* Sara Borden & Asani Sarkar, *Securitizing Property Catastrophe Risk*, Current Issues Econ. & Fin., Aug. 1996, at 1; Neil A. Doherty, *Financial Innovation in the Management of Catastrophe Risk*, J. Applied Corp. Fin., Fall 1997, at 84. Neil Doherty describes the different combinations of credit risk, basis risk, and the risk of moral hazard and adverse selection depending on whether the specific capital market instrument managing catastrophic risk belongs to one of the four following categories: asset hedge; liability hedge; post-loss equity recapitalization; or leverage management.

triggers—insurer-specific catastrophe losses, i.e., indemnity trigger, insurance-industry catastrophe loss indices, i.e., index trigger, and parametric indices based on the physical characteristics of catastrophic events, i.e., parametric trigger.[77] An important consideration in the choice between an indemnity trigger and the two other triggers is the relative cost of moral hazard versus basis risk.[78] Securities based on insurer-specific losses have no (or limited) basis risk but expose investors to moral hazard whereas securities based on industry loss indices or parametric triggers greatly reduce or eliminate moral hazard but create the problem of basis risk. Index triggers are also expected to have lower transaction costs and higher liquidity than indemnity triggers because it is easier to standardize contracts and report losses on an index versus having a range of contract specifications and triggering criteria depending upon the characteristics of the issuer as with insurer-specific contracts. Further, the use of an industry loss index as a payout trigger minimizes adverse selection.[79] Additionally, all ILS usually come without credit risk. Thus, index-linked coverage comes to dominate insurer-specific contracts whenever the credit risk on (re)insurance exists and provided that basis risk is sufficiently low.[80] However, insurance companies may not receive full indemnity when using index-based products as risk transfer instruments. In sum, investors prefer non-indemnity triggers to indemnity triggers for catastrophe risks to reduce moral hazard risk and avoid the modeling uncertainty associated with secondary perils that can come with indemnity triggers.[81] Due to basis risk, non-indemnity triggers are more acceptable for large diversified (re)insurers than for clients with a narrow risk exposure. Despite a higher uncertainty regarding the underlying models, cat bonds remain attractive for investors, given their relative returns and low correlation to other fixed-income investment.

Contingent capital usually entails a low trading volume, which exposes investors to liquidity risk.[82] The bespoke design of this financial product may further limit investors' ability to change their positions. Further, contingent capital products are based on triggers that are activated by a stated level of loss. The triggers can be created on a customized basis in order to match a company's exposure to a specific loss-making event, or they can be based on market indices that are widely tracked (this is similar to the triggers found on ILS). When triggers are indemnity-based, a company reduces its basis risk but increases the specter of moral hazard, and will generally face a higher cost in securing contingent financing.[83] If triggers are index- or parametric-based, moral hazard and associated costs decline, but basis risk increases. Additionally, investors in contingent capital bear the risk of adverse selection if only those companies with larger than average catastrophe risks issue securities.[84] Investors need to take such possibilities into account when evaluating a security's coupon payment. Finally, investors also bear credit risk because they face possible issuer default.

As regards exchange-traded derivatives, many financial market participants assume that markets for exchange-traded derivatives will provide sufficient liquidity to allow them to offset their market risk exposures quite promptly, even during episodes of market volatility when other financial markets may be relatively illiquid. Liquidity risk can anyhow be lowered by, for example, the participation of non-insurance entities in the capital markets, enabling them to take positions on industrywide catastrophe risks. As regards basis risk, only until the exchange-traded sector can identify catastrophe indices that more precisely match the needs of end-users and intermediaries, basis risk will continue to plague contract design. There can thus be significant basis risk when the correlation between the derivatives hedge and the risky position is weak, or breaks down in a crisis—exactly when effective hedging is needed most. But the size of the basis risk will also vary, since, first, the insurer's own losses will contribute to the index, but for many insurers this will be modest, and second, to the extent that the primary insurer has a portfolio similar to that of the other insurers comprising the index, the basis risk will be small. Further, the risks of moral hazard and adverse selection, faced by the entity assuming catastrophe risk, are minimized by the standardized nature of the exchange-traded catastrophe derivatives: standardized instruments indeed prevent insurers from selecting only high-risk policies for trade. Finally, the credit risk faced by all participants is minimized by the clearinghouse, which ensures the financial integrity of all exchange-traded catastrophe derivatives.[85] After all, exchange-traded transactions are contracts traded on the open market, are marked to market, are guaranteed by the exchange, and thus do not carry credit risk.

The over-the-counter catastrophe derivatives, e.g. catastrophe swaps, are presumed to offer less liquidity than an exchange market because of the customized nature of some OTC contracts. Anyway, the trading volume of OTC derivatives—and their liquidity risk—will largely depend on insurers' demand for catastrophe risk diversification. The basis risk of catastrophe swaps will depend on the payment conditions

77. As a recapitulation, an "indemnity trigger" is based on an issuer's actual exposure to a particular predefined event. A "parametric trigger" is based on the occurrence of an event with one or more certain defined physical parameters. An "index trigger" is based on a recognized industry loss index. See the nice overview of advantages and disadvantages of all triggers, in Guy Carpenter 2004, *supra* note 22, at 7-8.

78. *See* Lee & Yu, *supra* note 23; Neil A. Doherty, *Innovations in Managing Catastrophe Risk*, 64 J. Risk & Ins. 713 (1997); Neil A. Doherty & Andreas Richter, *Moral Hazard, Basis Risk, and Gap Insurance*, 69 J. Risk & Ins. 9 (2002); Neil A. Doherty & Olivier Mahul, Mickey Mouse and Moral Hazard: Uninformative but Correlated Triggers (Wharton Sch. Working Paper, 2001), *available at* http://www.aria.org/rts/proceedings/2001/Doherty-Mahul.pdf.

79. *See* Sylvie Bouriaux & William L. Scott, *Capital Market Solutions to Terrorism Risk Coverage: A Feasibility Study*, 5 J. Risk Fin. 33 (Sept. 2003).

80. Andreas Richter, Catastrophe Risk Management: Implications of Default Risk and Basis Risk (Ill. State Univ., Working Paper, 2002), *available at* http://symposium.fbv.uni-karlsruhe.de/9th/papers/Ric.pdf. *See also* Jerry R. Skees, *A Role for Capital Markets in Natural Disasters: A Piece of the Food Security Puzzle*, 25 Food Pol'y 365 (2000).

81. *Securitization: New Opportunities for Insurers and Investors*, Sigma (Swiss Re, Zurich, Switz.), Issue No. 7/2006, at 29.

82. Borden & Sarkar, *supra* note 76, at 4.

83. Banks, *supra* note 5, at 137.

84. *See* Christopher L. Culp, *Contingent Capital: Integrating Corporate Financing and Risk Management Decisions*, J. Applied Corp. Fin., Spring 2002, at 46, 55.

85. *See also* GAO 2002, *supra* note 23, at 36; Niehaus, *supra* note 23.

of each individual swap agreement: if each party's individual claim payments determine its counterparty's payments, basis risk will be eliminated. However, if each party's payments are based on an industry aggregate, both swap participants will face basis risk. As regards the risk of moral hazard, this can be reduced by, for instance, prohibiting swap participants from transferring all of their policies so that careful policy management will be encouraged and moral hazard will be lessened. Moral hazard will further depend on the trigger used. Adverse selection, on its turn, can be reduced by requiring swap participants to provide policy and claim data to their counterparties. Finally, since OTC transactions are private transactions, each participant will be exposed to credit risk, i.e., the potential of counter-party default on the contract, especially since the derivatives' exchange will not serve as a clearinghouse guaranteeing trades.

In sum, the following graph represents a comparison of all capital market instruments managing (catastrophe) risks, according to their liquidity risk, basis risk, moral hazard and adverse selection, and credit risk:

	Liquidity risk	Basis risk	Moral hazard	Adverse selection	Credit risk
ILS + indemnity trigger	High	Limited	High	High	Absent
ILS + index/ parametric trigger	Low	High	Reduced	Reduced	Absent
Contingent capital + indemnity trigger	High	Limited	High	Only if those companies with larger than average catastrophe risks issue securities	Present
Contingent capital + index/parametric trigger	High	High	Reduced	Only if those companies with larger than average catastrophe risks issue securities	Present
Exchange-traded derivatives	Low	High	Minimized	Minimized	Minimized
OTC derivatives	High	Depends on payment conditions, present in deals with index trigger	Mitigated by contract design; low if index/ parametric trigger, medium if indemnity trigger	Can be reduced	Present

B. *Catastrophe Bonds Versus Catastrophe Reinsurance*

After having compared the three categories of capital market instruments according to their liquidity risk, basis risk, moral hazard, adverse selection, and credit risk, the most important capital market instrument managing catastrophe risks at present, namely catastrophe bonds, can also be compared with traditional catastrophe reinsurance.[86]

First, a very important feature of the catastrophe reinsurance market is its cyclic pricing nature, which has mainly been attributed to shortages of underwriting capacity and to the inaccessibility of information about prices. In contrast, one of the promises of the catastrophe bond market is that it will enable the issuers to circumvent capacity problems by providing what amounts to additional capacity to cover catastrophic losses.

A second feature, and at the same time limitation, of the traditional catastrophe reinsurance market is, according to Angelika Schöchlin, its tendency to provide cedant companies with risk financing rather than with risk transfer.[87] That is, after the insured is reimbursed for an actual loss, it is assumed that successive insurance will be bought from the same reinsurer, and at a higher price that compensates the provider for the past losses. Catastrophe bonds, on the other hand, provide cedant companies with the possibility of pure risk transfers, since the terms of the insurance provided are largely independent of previous outcomes. This can be explained by the fact that capital market investors are likely to be better diversified than most insurance companies, suggesting the greater capacity of the capital markets for genuine risk transfer.

Third, in addition to capacity shortages and limited risk transfer, traditional catastrophe reinsurance faces credit risk. The (re) insurance industry can indeed be impacted tremendously if the financial condition of reinsurers cannot cope with the consequences of a catastrophic event. Catastrophe bonds, in contrast, pose no or minimal credit risk to insurers because the funds are immediately deposited into a trust account upon the bonds' issuance to investors.

Fourth, asymmetric information between reinsurers on an insurer's risk affects competition in the reinsurance market: reinsurers are subject to adverse selection, since only high-risk insurers may find it optimal to

86. See amongst many: Harrington, *supra* note 56; Nell & Richter, *Improving Risk Allocation*, *supra* note 23; Fred Wagner, *Risk Securitization: An Alternative of Risk Transfer of Insurance Companies*, 23 Geneva Papers Risk & Ins. 574 (1998); Schöchlin, *supra* note 23; Schöchlin, *supra* note 30; Nell & Richter, Working Paper, *supra* note 23.

87. Schöchlin, *supra* note 23, at 102.

change reinsurers.[88] As a result, high reinsurance prices and cross-subsidization of high-risk insurers by low-risk insurers will follow. In contrast, catastrophe bonds with an index or parametric trigger are insensitive to information asymmetry, since the value of a cat bond with such a trigger is independent of the insurer's expected loss. Therefore, the adverse selection problem does not arise in the case of catastrophe bonds with information-insensitive triggers.

A fifth branch of comparison relates to risk premiums. Traditional catastrophe reinsurance has the tendency to increase premiums after a catastrophic event and with the eye on future hazards. Catastrophe bonds, on the other hand, are only weakly correlated with market risk, implying that in perfect financial markets these securities could be traded at a price including just small risk premiums.[89] In reality however, legal doctrine talks about a cat bond pricing (or premium) puzzle: the risk premiums on cat bonds are several times larger than the expected losses (the median risk-premium to expected-loss multiple is between six and seven).[90]

On the other hand, a preference for traditional reinsurance could also be sustained. Apart from the seemingly high pricing of catastrophe bonds, a preference for traditional reinsurance as compared to cat bonds could be the result of the long-standing business relationships of insurers with their reinsurers and the general nature of reinsurance contracts. Reinsurance contracts indeed typically cover an insurer's losses, such as those resulting from earthquakes in a specified area up to a specified limit. In contrast, catastrophe bonds focus on one type of risk (for example, a natural catastrophe) and can be highly customized (for example, the development of parametric triggers), which may add to their administrative costs and require a greater commitment of management time to develop, particularly the first time that they are used. Further, Bantwal and Kunreuther have proven that ambiguity aversion, myopic loss aversion, and fixed costs of education can also account for the reluctance of institutional investors to enter the catastrophe bond market.[91]

Finally, while credit risk is indeed present with traditional catastrophe reinsurance, there is no basis risk because reinsurance payoffs are geared to losses sustained by the primary insurer. All financial instruments, in contrast, including catastrophe bonds, have introduced basis risk, resulting from the fact that this kind of coverage cannot be a perfect hedge for the insured portfolio. The introduction of basis risk, on its turn, can be seen as a method of addressing moral hazard, a problem the reinsurance industry is regularly confronted with—both ex ante and ex post moral hazard.[92]

To conclude, strong interdependencies between reinsurance and (especially indexed) catastrophe bonds can be observed.[93] The demand for indexed cat bonds cannot be advantageous if catastrophe reinsurance coverage is offered at fair prices in a market with complete information and without credit risk.[94] This implies that factors such as transaction costs, moral hazard, and/or credit risk in the reinsurance contracts are a *conditio sine qua non* for the attractiveness of catastrophe bonds, which may suffer from high administrative costs. Hence, the demand for cat bonds can only be explained via imperfections in the reinsurance market, since cat bonds always result in a basis risk for the insurer. The optimal mix of catastrophe risk allocation instruments should thus entail that small losses are mainly covered by reinsurance contracts, while large losses are covered by catastrophe index-linked securities.[95]

	Catastrophe bonds	Catastrophe reinsurance
Capacity?	Provides additional capacity	Reinsurance cycles
Risk financing or transfer?	Pure risk transfer	Risk financing
Credit Risk?	Absent	Present
Risk premiums?	Weak correlation with catastrophe risk, but high pricing anyway	Increase in aftermath of catastrophe
Administrative costs?	High	Low
Basis risk?	High	Low
Moral hazard?	Low	High
Adverse selection?	Low if with index/parametric trigger	High

VII. Capital Markets and the Terrorism Risk

The capital market instruments, as described above, mainly relate to natural catastrophes. Also economic literature only seems to be a judge of capital market instruments in the context of natural disasters. A strong link between financial

88. *See* Silke Finken & Christian Laux, *Catastrophe Bonds and Reinsurance: The Competitive Effect of Information-Insensitive Triggers*, 76 J. Risk & Ins. 579 (2009); James R. Garven & Martin F. Grace, Adverse Selection in Reinsurance Markets (Ga. State Univ., Working Paper, 2007).
89. See also the discussion *supra* regarding the costs associated with catastrophe bonds vis-à-vis reinsurance.
90. *See* J. David Cummins et al., *The Basis Risk of Catastrophic-Loss Index Securities*, 71 J. Fin. Econ. 77 (2004). Other possible explanations for the phenomenon of a cat bond premium puzzle include moral hazard, the illiquidity of the cat bonds, uncertainty about expected loss estimates, and investor unfamiliarity with the contracts ("novelty premium").
91. According to the authors, potential investors should be able to overcome these obstacles after they are comfortable with both the complexity and the uncertainty of the cat bond market. Issuers can address the former by standardizing a simple structure of terms, so that an investor's fixed cost of education on their first cat bond will not require them to incur additional high costs when evaluating future issues. Quantifying and reducing pricing uncertainty can help investors overcome their aversion to ambiguity. *See* Bantwal & Kunreuther, *supra* note 23.
92. *See* Doherty, *supra* note 76.
93. The reason for dealing with indexed cat bonds is that indexing ameliorates the moral hazard problem: non-indemnity-based coverage is a means to limit moral hazard for the investor by tying payment to industry loss indices, parametric measures, and models of claims payments, rather than actual claims that could be affected by lax underwriting standards or lax settlement of claims by the ceding insurer. However, such coverage introduces basis risk for the sponsoring insurance company.
94. Nell & Richter, Working Paper, *supra* note 23.
95. *See* Doherty & Richter, *supra* note 78; Nell & Richter, *Improving Risk Allocation*, *supra* note 23.

instruments and manmade catastrophes has not been made so far, although a connection with the terrorism risk is finally being explored,[96] especially since the first catastrophe bonds to protect against terrorism risk have appeared.

A. *The Potential of Capital Market Instruments to Undertake Terrorism Coverage*

It is well known that the terrorism risk does not lend itself well to the pooling mechanism of insurance, since the law of large numbers cannot be used, there is little predictive capability, the inputs needed to simulate the financial and business consequences of a terrorist attack are unknown, and quantification is impossible due to the lack of a historical database. This difficulty of quantifying the terrorism risk may lead to an underestimation of future losses. As a result, insurance companies must maintain a significant amount of surplus beyond the premium collected. This could prove difficult and the cost of terrorism insurance could rise to prohibitive levels. Therefore, the terrorism risk is seen as almost uninsurable. Even stock companies could have trouble raising capital as existing or potential stockholders may reject investing in companies that undertake such unconventional risks. Terrorism risk hence requires new risk-underwriting alternatives.

In theory, capital markets are good candidates to undertake terrorism risk coverage. Insurance companies would need extensive capital to be able to cover terrorism risk. This need suggests the need for risk transfer, as opposed to risk pooling, a function that is just appropriate to the capital markets. Moreover, this extra capacity would lessen the upward pressure on insurance premiums. Another advantage of the use of capital market instruments for terrorism coverage includes lower production costs, since capital markets introduce efficiencies in the underwriting, monitoring, and settling of terrorism insurance. Additionally, risk diversification and a low correlation with stock and bond returns could be reached with the introduction of financial instruments. However, whether or not this diversification element would work in the case of terrorism is not clear, according to Sylvie Bouriaux and William Scott.[97]

In practice, insurance-linked securitization struggles with, amongst others, basis risk and the lack of sufficient market liquidity. Unfortunately, the nature of terrorism risk will likely accentuate the basis risk issue. Favorite terrorist targets seem to be large and to point at famous buildings, public places where a lot of people regularly gather such as metro stations, and so forth. If the underlying loss index would only include these likely terrorist targets, then insurers who concentrate on e.g. small cities may not be able to effectively hedge their catastrophe risks. As a result, customized financial instruments will be developed rather than standardized. Such lack of standardization would hamper voluntary market trading liquidity.

96. This section is based upon Bouriaux & Scott, *supra* note 79. *See also* GAO 2003, *supra* note 23.
97. Bouriaux & Scott, *supra* note 79.

B. *A Market for Terrorism Catastrophe Bonds?*

As stated above, terrorism catastrophe bonds could in theory be a viable alternative to traditional reinsurance and could transfer risk to the deep pool of the global capital markets. However, in practice, a market for terrorism cat bonds has not emerged since the terrorist attacks of 9/11[98] and the lack of credible mathematical models of terrorism risk, ambiguity aversion, myopic loss aversion, the fixed costs of education, the moral hazard problem, and the reluctance of reinsurers to provide protection will have as a consequence that terrorism bonds are not likely to be a significant provider of terrorism coverage in the next few years.[99]

To conclude, and having in mind that the past record may not bode well for the development of insurance-linked capital market instruments directed to the terrorism risk, Bouriaux and Scott suggest, after having constructed a simulation exercise, that it is not favorable to recommend that the capital market alone be enlisted to underwrite terrorism risks.[100] Both authors found, first, that risk transferors will pay a high price to buy terrorist coverage from the capital markets, because there is a significant premium attached to the lack of predictability in terrorist losses. Second, terrorism coverage is a longer tail business, compared to natural catastrophe coverage, which makes terrorism risk even harder to securitize than catastrophe risk. And additionally, previous experience shows that institutional investors have been reluctant to invest in catastrophe-linked securities because of adverse selection and moral hazard issues.

VIII. Conclusions

Insurance and reinsurance companies have turned to the capital markets in an attempt to seek more funding with an eye to future disastrous events. After all, past events have shown the incapability of several (re)insurers to adequately compensate victims of catastrophes (there are so-called capacity gaps) and numerous insurance companies became insolvent.[101] Capital markets can fund insurance and reinsurance companies, whereby the funding comes from securities—in all sorts—sold to capital market investors. However, each approach to securitizing catastrophe risk, i.e. insurance-linked securities, contingent capital, and catastrophe

98. To date, only two terrorism-related cat bonds have been issued. Neither of these, however, is actually a pure terrorism cat bond issued for a specific type of attack; both are multi-event cat bonds associated with the risk of terrorist attack and the risk of natural disasters or pandemic.
99. *See* Org. for Econ. Cooperation & Devel., Terrorism Risk Insurance in OECD Countries 55-65 (2005); Howard C. Kunreuther & Erwann Michel-Kerjan, *Dealing With Extreme Events: New Challenges for Terrorism Risk Coverage in the U.S.* (Wharton Risk Mgmt. & Decision Processes Ctr., Paper No. WP 04-09, 2004); Howard C. Kunreuther et al., Assessing, Managing, and Financing Extreme Events: Dealing With Terrorism (Nat'l Bureau of Econ. Research, Working Paper No. 10179, Dec. 2003), *available at* http://www.nber.org/papers/w10179.
100. Bouriaux & Scott, *supra* note 79.
101. For example, nine insurance companies were insolvent as a result of Hurricane Andrew in 1992, adding to the financial burden of other insurers, leading to even a 10th company becoming insolvent. Paul R. Kleindorfer & Howard C. Kunreuther, *Challenges Facing the Insurance Industry in Managing Catastrophic Risks*, *in* Financing of Catastrophe Risk, *supra* note 2, at 149, 152.

derivatives, has unique advantages and disadvantages, as was discussed when comparing the various instruments according to their liquidity risk, basis risk, moral hazard, adverse selection, and credit risk.

Generally, the following advantages can be attributed to all capital market instruments as a mechanism to fund catastrophe risks:[102] (1) providence of increased (potential) market capacity, much wider than the capacity the insurance industry alone has available; (2) surplus relief; (3) insurers can invest excess capital in higher return projects; (4) increase risk/reward profile of an investment portfolio; (5) more efficient portfolio: because natural catastrophe losses are so-called zero-beta events, securities may provide a valuable new source of diversification for investors[103]; (6) low correlation with stocks and bond returns; (7) coverage for multi-risks is available; (8) coverage for periods of several years is possible; (9) flexibility; (10) risks that are correlated within insurance and reinsurance markets may be uncorrelated with other risks in the economy[104]; (11) if properly structured, securitized financial instruments can significantly reduce or eliminate the credit risk (insolvency risk) inherent in reinsurance policies; and generally (12) intellectually challenging products.

On the other hand, the general disadvantages include: (1) lack of liquidity in both the securities market and in the derivatives market; (2) possible unfavorable regulatory treatment (especially in the United States); (3) lack of sufficient experience; (4) expenditures incurred will only pay back if amounts invested or loss potentials, respectively, are sufficiently large; (5) moral hazard problem, although this depends on the trigger used; (6) basis risk; etc.

Further, the transfer of catastrophe risks to the capital markets can be considered a potentially powerful solution to the catastrophe (re)insurance capacity problem.[105] Indeed, natural disasters have, according to Schöchlin, proven to be insurable by the capital markets.[106] Dwight Jaffee and Thomas Russell and Kenneth Froot even argue that securitization offers a potentially more efficient mechanism for financing catastrophe losses than traditional insurance and reinsurance.[107] However, the optimal amount and mix of risk financing depends on the relative costs of capital, reinsurance, and securitization, and on each insurer's unique characteristics. The amount of business each insurer writes, the geographic distribution of that business, and other factors determine the variance in the insurer's losses. That variance and the insurer's tolerance for risk affect the overall amount of risk financing that the insurer should have.[108] Moreover, in the long run, securitization of catastrophe risks will only succeed if, in practice, (re)insurers find that the use of capital market instruments is a cost-effective means of spreading their risk, and if investors find that securitizing catastrophe risk enhances the performance of their portfolios.

In sum, it can be noted that the insurance/reinsurance market and the capital markets are gradually converging, with institutions from the two sectors becoming increasingly involved in each other's lines of business.[109] Financial intermediaries are actively involved in insurable risks and markets, while (re)insurers routinely participate in financial risks. This convergence generates important benefits, including efficiency and cost savings, the reduction of price volatility that could arise from capacity constraints, and the creation of greater stability for those trying the actively manage their risks. In fact, any holistic view of catastrophe risk management requires a focus on both sectors, and how they can be used jointly to create optimal solutions. Catastrophe bonds and other structures of the capital markets are designed to work in concert with, rather than as replacements for, catastrophe insurance/reinsurance.[110] Said in other words, financial market instruments should be characterized as a supplement, rather than an alternative, to (re)insurance.[111] This process of convergence is expected to continue. However, so far, no securitization has involved manmade disasters, except for terrorism risk.

Last but not least, what is the relevance of capital market instruments in light of the financial crisis of 2007-2008? The comforting words of J. David Cummins and Philippe Trainar undoubtedly provide us with relief:

> Due to its weak correlation with financial risks, insurance securitization should have been able to resist the crisis better than other forms of securitization. In fact, this is what has happened. Until the summer of 2008, insurance securitization escaped the crisis relatively unscathed, with the exception of embedded value and regulatory securitization, which are more tightly correlated with financial risks. While the securitization counter rapidly closed for financial risks, precisely because of the explosion in spreads, it stayed open for insurance risks. And while spreads exploded for securitization in general, they remained relatively stable for the securitization of insurance risks. And, in fact, the market for these risks remained relatively liquid during this period, which was a non-negligible plus for investors. To be sure, the good behavior of the insurance securitization market after July 2007 is not only due to the decorrelation of insur-

102. *See* Jürgen Zech, *Will the International Financial Markets Replace Traditional Insurance Products?,* 23 Geneva Papers Risk & Ins. 490 (1998); Insurance Services Office, *Financing Catastrophe Risk: Capital Market Solutions* (1999), *available at* http://www.iso.com/Research-and-Analyses/Studies-and-Whitepapers/Financing-Catastrophe-Risk-Capital-Market-Solutions.html.
103. *See* Canter et al., *supra* note 64; Litzenberger et al., *supra* note 29.
104. *See* J. David Cummins & Philippe Trainar, *Securitization, Insurance, and Reinsurance*, 76 J. Risk & Ins. 463 (2009).
105. It has to be noted that both sidecars and ILWs have not been extensively considered in this Article, although they provide viable alternatives to traditional reinsurance and catastrophe bonds for mitigating losses from such events.
106. Schöchlin, *supra* note 23, at 107.
107. *See* Kenneth A. Froot, *The Evolving Market for Catastrophic Event Risk*, Risk Mgmt. & Ins. Rev., Sept. 1999, at 1; Dwight M. Jaffee & Thomas Russell, *Catastrophe Insurance, Capital Markets, and Uninsurable Risks*, 64 J. Risk & Ins. 205 (1997).
108. Insurance Services Office, *supra* note 102.
109. *See, e.g.*, J. David Cummins & Mary A. Weiss, *Convergence of Insurance and Financial Markets: Hybrid and Securitized Risk-Transfer Solutions*, 76 J. Risk & Ins. 493 (2009).
110. Banks, *supra* note 25, at 111.
111. It must, however, be noted that sponsors of catastrophe bonds view these capital market instruments as alternatives to traditional reinsurance when they are more cost-effective. Also Cummins and Trainar are of the opinion that reinsurance and securitization may be substitutes for certain types of risk, such as the risk of large catastrophes. *See* Cummins & Trainar, *supra* note 104.

> ance and financial risks; it is also attributable to the investors who switched a portion of their funds gradually, as other segments of the financial market shut down. The closing of the window on insurance securitization, which came in the course of the summer and fall of 2008 after the failure of Lehman Brothers, does not contradict this observation."[112]

The conclusion of these authors supports the suggestion made in this paper that capital market instruments seem to have overcome in a healthy state the financial crisis and that therefore a bright future lies ahead for capital market instruments in the area of catastrophe risks!

112. *See id.*