Alternative risk transfers

*Alternative Risk Transfer* (ART) is the use of techniques other than traditional insurance and reinsurance to provide risk-bearing entities with insurance-like coverage/protection. The field of ART grew out of a series of insurance capacity crises in the 1970s through 1990s that drove purchasers of traditional coverage to seek alternative ways to buy protection. Most of these techniques permit investors in the capital markets to take a more direct role in providing insurance and reinsurance protection, and as such the broad field of ART is said to be bringing about a convergence of insurance and financial markets.

**Key Areas of ART Activity**

A major sector of ART activity is risk securitization including catastrophe bonds and Reinsurance Sidecars. Standardization and trading of risk in non-indemnity form is another area of ART and includes Industry Loss Warranties. In addition, a number of approaches involve funding risk transfer, often within the structures of the traditional reinsurance market. Captive Insurance Companies are formed by firms and re/insurers to receive premiums that are generally held and invested as a "funded" layer of insurance for the parent company. Some captives purchase excess of loss reinsurance and offer coverage to third parties, sometimes to leverage their skills and sometimes for tax reasons. Financial reinsurance in various forms (finite, surplus relief, funded, etc.) consists of various approaches to reinsurance involving a very high level of prospective or retrospective premiums relative to the quantity of risk assumed. While such approaches involve "risk finance" as opposed to "risk transfer," they are still generally referred to under the heading of ART. ART is often used to refer to activities through which re/insurers transform risks from the capital markets into insurance or reinsurance form. Such transformation can occur through the policy itself, or through the use of a transformer reinsurer. This type of activity has been important in credit risk markets, hard asset value coverage and weather markets. Reinsurers were notable participants in the early development of the synthetic CDO and weather derivative markets through such activities. A subset of activities in which reinsurers take capital markets risks is dual-trigger or multiple trigger contracts. Such contracts exist between a protection buyer and a protection seller, and require that two or more events take place before a payment from the latter to the former is "triggered." For example, and oil company may desire protection against certain natural hazards, but may only need such protection if oil prices are low, in which case they would purchase a dual trigger derivative or re/insurance contract. There was a great deal of interest in such approaches in the late 1990's, and re/insurers worked to develop combined risk and enterprise risk insurance. Reliance Insurance extended this further and offered earnings insurance until the company suspended its own business operations. This area of ART activity diminished after the general hardening of the commercial insurance and reinsurance markets following the September 11, 2001 terrorist attacks.

Another area of convergence is the emergence of pure insurance risk hedge funds such as Nephila, Fermat, Securis, Coriolis, Pentalia, Goldman Sachs Catastrophe Fund, Stark Catastrophe Fund, Acuance, Solidum. These function economically like fully collateralized reinsurers (and some of them operate through reinsurance vehicles, such as
Nephila's Posiden Re and Goldman's Steamboat Re), but take the form of hedge funds. A more specialized version is Gamut Re, a tranched collateralized risk obligation managed by Nephila.

Life insurance companies have developed a variety of ART approaches including Life Insurance Securitization, full recourse reserve funding, funded letters of credit, surplus relief reinsurance, administrative reinsurance and related approaches. Because life reinsurance is relatively more "financial" to begin with, there is less separation between the conventional and alternative risk transfer markets than in the property & casualty sector. Emerging areas of alternative risk transfer include intellectual property insurance, automobile insurance securitization and life settlements.

**Key market participants**

- Investment banks, notably Goldman Sachs, Lehman Brothers, Merrill Lynch and Citibank.
- Insurers, including AIG, Zurich, USAA and XL.
- Reinsurers, notably Munich Re, Hannover Re and Swiss Re both directly and through their capital markets subsidiaries.
- Brokers including Artex Risk Solutions, Willis, Marsh, Aon Corporation, Benfield, and RK Carvill.

**Key sectors**

Key sectors of the Alternative Risk Transfer marketplace include the use of Captive Insurance companies, financial reinsurance, Finite Risk insurance, catastrophe bonds, Reinsurance Sidecars, contingent capital, captive insurers and reinsurers, dual trigger insurance, industry loss warranties, weather derivatives.

**Catastrophe bond**

*Catastrophe bonds* (also known as *cat bonds*) are risk-linked securities that transfer a specified set of risks from a sponsor to investors. They are often structured as floating rate corporate bonds whose principal is forgiven if specified trigger conditions are met. They are usually used by insurers as an alternative to traditional catastrophe reinsurance. For example, if an insurer has built up a portfolio of risks by insuring properties in Florida, then it might wish to pass some of this risk on so that it can remain solvent after a large hurricane. It could simply purchase traditional catastrophe reinsurance, which would pass the risk on to reinsurers. Or it could sponsor a cat bond, which would pass the risk on to investors. In consultation with an investment bank, it would create a special purpose entity that would issue the cat bond. Investors would buy the bond, which might pay them a coupon of LIBOR plus a spread. If no hurricane hit Florida, then the investors would make a healthy return on their investment. But if a hurricane were to hit Florida and trigger the cat bond, then the principal initially paid by the investors would be forgiven, and instead used by the sponsor to pay its claims to policyholders.
Structure

**History**
The notion of securitizing catastrophe risks became prominent in the aftermath of Hurricane Andrew, notably in work published by Richard Sandor, Ken Froot, and a group of professors at the Wharton School who were seeking vehicles to bring more risk-bearing capacity to the catastrophe reinsurance market. The first experimental transactions were completed in the mid-1990s by AIG, Hannover Re, St. Paul Re, and USAA. The market grew to $1-2 billion of issuance per year for the 1998-2001 period, and over $2 billion per year following September 11, 2001. Issuance doubled again to a run rate of approximately $4 billion on an annual basis in 2006 following Hurricane Katrina, and was accompanied by the development of Reinsurance Sidecars. Issuance continued to increase through 2007 despite the passing of the post-Katrina "hard market," as a number of insurers sought diversification of coverage through the market, including State Farm, Allstate, Liberty Mutual, Chubb, and Travelers, along with long-time issuer USAA. Total issuance exceeded $4 billion in the second quarter of 2007 alone.

**Investors**
Investors choose to invest in catastrophe bonds because their return is largely uncorrelated with the return on other investments in fixed income or in equities, so cat bonds help investors achieve diversification. Investors also buy these securities because they generally pay higher interest rates (in terms of spreads over funding rates) than comparably rated corporate instruments, as long as they are not triggered. Key categories of investors who participate in this market include hedge funds, specialized catastrophe-oriented funds, and asset managers. Life insurers, reinsurers, banks, pension funds, and other investors have also participated in offerings. A number of specialized catastrophe-
oriented funds play a significant role in the sector, including Horizon21, Clariden Leu Ltd., Credit Suisse Asset Management, Fermat Capital Management, Nephila, Stark, Securis, Coriolis, Banque AIG, Solidum, Pentelia Capital Management, Goldman Sachs Asset Management, Secquaero Advisors, and others. Several mutual fund managers also invest in catastrophe bonds, among them OppenheimerFunds, Pioneer Investments, and PIMCO.

**Ratings**
Cat bonds are commonly rated by agencies: Standard & Poor's, Moody's, or Fitch Ratings. A typical corporate bond is rated based on its probability of default due to the issuer going into bankruptcy. A catastrophe bond is rated based on its probability of default due to an earthquake or hurricane triggering loss of principal. This probability is determined with the use of catastrophe models. Most catastrophe bonds are rated below investment grade (BB and B categories S&P ratings are typical), and the various rating agencies have recently moved toward a view that securities must require multiple events before occurrence of a loss in order to be rated investment grade.

**Structure**
Most catastrophe bonds are issued by special purpose reinsurance companies domiciled in the Cayman Islands, Bermuda, or Ireland. These companies typically write one or more reinsurance policies to protect buyers (most commonly, insurers or reinsurers) called cedants. This contract may be structured as a derivative in cases in which it is triggered by one or more indices or event parameters, rather than losses of the cedant. Some bonds cover the risk that multiple losses will occur. The first second event bond (Atlas Re) was issued in 1999. The first third event bond (Atlas II) was issued in 2001. Subsequently, bonds triggered by fourth through ninth losses have been issued, including Avalon, Bay Haven, and Fremantle, each of which apply tranching technology to baskets of underlying events. The first actively managed pool of bonds and other contracts ("Catastrophe CDO") called Gamut was issued in 2007, with Nephila as the asset manager.

**Trigger types**
The sponsor and investment bank who structure the cat bond must choose how the principal impairment is triggered. Cat bonds can be categorized into four basic trigger types. The trigger types listed first are more correlated to the actual losses of the insurer sponsoring the cat bond. The trigger types listed farther down the list are not as highly correlated to the insurer's actual losses, so the cat bond has to be structured carefully and properly calibrated, but investors would not have to worry about the insurer's claims adjustment practices.

*Indemnity*: triggered by the issuer's actual losses, so the sponsor is indemnified, as if they had purchased traditional catastrophe reinsurance. If the layer specified in the cat bond is $100 million excess of $500 million, and the total claims add up to more than $500 million, then the bond is triggered.

*Modeled loss*: instead of dealing with the company's actual claims, an exposure portfolio is constructed for use with catastrophe modeling software, and then when there is a large
event, the event parameters are run against the exposure database in the cat model. If the modeled losses are above a specified threshold, the bond is triggered.

*Indexed to industry loss:* instead of adding up the insurer's claims, the cat bond is triggered when the insurance industry loss from a certain peril reaches a specified threshold, say $30 billion. The cat bond will specify who determines the industry loss; typically it is a recognized agency like PCS. "Modified index" linked securities customize the index to a company's own book of business by weighting the index results for various territories and lines of business.

*Parametric:* instead of being based on any claims (the insurer's actual claims, the modeled claims, or the industry's claims), the trigger is indexed to the natural hazard caused by nature. So the parameter would be the wind speed (for a hurricane bond), the ground acceleration (for an earthquake bond), or whatever is appropriate for the peril. Data for this parameter is collected at multiple reporting stations and then entered into specified formulae. For example, if a typhoon generates wind speeds greater than X meters per second at 50 of the 150 weather observation stations of the Japanese Meteorological Agency, the cat bond is triggered.

*Market participants*
Examples of cat bond sponsors include insurers, reinsurers, corporations, and government agencies. Over time, frequent issuers have included USAA, Hartford, Swiss Re, Munich Re, Liberty Mutual, SCOR, Hannover Re, Allianz, and Tokio Marine & Fire. To date, all direct catastrophe bond investors have been institutional investors, since all broadly distributed transactions have been distributed in that form. These have included specialized catastrophe bond funds, hedge funds, investment advisors (money managers), life insurers, reinsurers, pension funds, and others. Individual investors have generally purchased such securities through specialized funds. Examples of investment banks and other dealers that are active in the issuance of catastrophe bonds are ABN AMRO, Aon Capital Markets, Barclays Capital, Deutsche Bank, BNP Paribas, Goldman Sachs, Merrill Lynch, MMC Securities Corp., Lehman Brothers, Swiss Re Capital Markets, and Willis Capital Markets. Some of these groups also make secondary markets in these bonds. Most bond offering documents include an expert modeling analysis, with the bulk of these being prepare by AIR Worldwide, EQEcat, and Risk Management Solutions. Applied Research Associates and Milliman also provide research and technical support.

*Patents*
There are a number of issued US patents and pending US patent applications related to catastrophe bonds. These are examples of insurance patents. Insurance patents are a recent trend since the 1998 State Street Bank decision affirmed that business method patents were allowed by United States patent law. There are approximately 150 new patent applications filed each year on new insurance products and processes.

Cat bond calculator: [http://nuscho.com/catbonds.aspx](http://nuscho.com/catbonds.aspx)
Reinsurance sidecar

Reinsurance sidecars, conventionally referred to as Sidecars, are financial structures which are created to allow investors to take on the risk and return of a group of insurance policies (a "book of business") written by an insurer (or reinsurer) and earn the risk and return that arises from that business. A reinsurer will only pay ("cede") the premiums associated with a book of business to such an entity if the investors place sufficient funds in the vehicle to ensure that it can meet claims if they arise. Typically the liability of investors is limited to these funds. These structures have become quite prominent in the aftermath of Hurricane Katrina as a vehicle for re/insurers to add risk-bearing capacity, and for investors to participate in the potential profits resulting from sharp price increases in re/insurance over the four quarters following Katrina. An earlier and smaller generation of sidecars were created after September 11, 2001 for the same purpose.

Precedents

Sidecars have precedents in the reinsurance market under the name "quota-share reinsurance." In such an agreement, an insurer agrees to cede to the quota-share reinsurer a percentage of all premiums arising from a book of business in exchange for the reinsurer bearing the same percentage liability for losses. The quota-share reinsurer pays an amount called the ceding commission to compensate the ceding company for its expenses. The ceding commission typically also includes a profit allowance, which increases in proportion to the expected profitability of the business. These reinsurance treaties currently and traditionally provide ceding companies with the ability to write more business than they could bear based on their own capital and to earn a certain amount of fee-based income (through the ceding commission). Quota-share reinsurers act as insurance wholesalers, allowing them to earn a return on capital without creating primary insurance distribution. Lloyd's of London "names" act as such reinsurers, placing the resources of individual and firms at risk to books of business written by professional underwriters and agents.

Early sidecars: reinsurance joint ventures

Insurers have occasionally created joint ventures through which multiple parties place capital at the disposal of one or more expert underwriters for the same reasons. The earliest sidecars were created in Bermuda in the 1990s in such a fashion, and included Top Layer Re and OpCat, both of which placed capacity under the control of Renaissance Re on the part of other re/insurers (Overseas Partners, State Farm).

Market growth following September 11, 2001 and Hurricane Katrina

In the years following September 11, 2001, the idea of raising funds from capital markets investors in addition to re/insurers to support quota-shares arose, and a handful of such ventures were consummated (Olympus, DaVinci, Rockridge). These were the first true sidecars, and were a natural outgrowth of the development of re/insurance as an asset class in the form of catastrophe bonds. Following Hurricane Katrina the sidecar idea became very prominent among investors because it was seen as a way to participate in the risk/return of the higher-priced ("hard") reinsurance market without investing in either existing reinsurers (who might have liabilities from the past that would undermine returns) or new reinsurers ("newcos" that would have a lengthy and expensive "ramp up"
period). Three such entities were up and running by year-end 2005 (sidecar, capital raised, ceding re/insurer, book of business).

- Flatiron, $840mm, Arch Capital
- Blue Ocean, $355mm, Montpelier Re
- Cyrus, $550mm, XL Capital

These entities have been created since 2006 (sidecar, capital raised, ceding re/insurer, book of business):

- Petrel, $200mm, Validus, marine and energy reinsurance
- Kaith/K5, $370mm, Hannover Re, several lines of insurance and reinsurance
- Helicon, $330mm, White Mountains Re, property catastrophe reinsurance
- BayPoint, $150mm, Harbor Point, selected short-tailed lines of business
- Timicuan/RPP, $70mm, Renaissance Re, reinstatement premium protection
- Starbound, $315mm, Renaissance Re, Florida treaty business
- Sector Re, $220mm, Swiss Re, property catastrophe and aviation reinsurance
- Castlepoint Re, $265mm, Tower Group, program and specialty insurance
- Monte Fort Re, $60mm, Flagstone Re, peak zone and ILW (industry loss warranty) coverage
- Sirocco, $95mm, Lancashire Re, Gulf of Mexico offshore energy
- Concord, $730mm, AIG, US commercial property business
- MaRI, $400mm, Marsh / ACE, US commercial property

Together with supplementary capital raises at Olympus, DaVinci, Blue Ocean and Kaith, this brought the total capital raised to over $4bn by September 2006 and established sidecars as a major capital-raising vehicle for catastrophe risk.

By year end 2006 it began to appear as though supply and demand in the reinsurance and catastrophe bond markets had achieved balance at the prevailing price level, and the market began to "soften" (fall in price), particularly following the decision by the State of Florida to expand the size of the reinsurance protection offered by the Florida Hurricane Catastrophe Fund by at least $12 billion in January 2007. Creation of new sidecars slowed markedly in the first half of 2007 in consequence, with only one transaction being closed that included an equity offering (Starbound II, itself in some respects as much a rollover of Starbound I as a new transaction). The sidecar market continued to be active however with three different issuers accessing the bank loan market for debt to leverage their own equity: Hannover Re (Kepler), the Citadel reinsurance companies (Emerson) and State Farm (Merna).

Sidecar investments
Investors are typically offered debt (generally in the form of bank loans), preferred stock and equity investments in the sidecar. Debt may be rated by the rating agencies: Standard & Poors, Moody's, and A. M. Best. Most sidecar debt has been rated in the "BB" category (below investment grade) but some investment grade debt has been issued. In 2007 the rating agencies offered detailed criteria discussions for this type of issuance.

Market participants
- Investment banks including Aon Capital Markets, Goldman Sachs, Merrill Lynch, Morgan Stanley, Swiss Re Capital Markets and Deutsche Bank have advised on
the creation of sidecars, typically alongside specialist consultancies such as Risk Management Solutions.
- Lead equity investors that have been publicly disclosed include J.C. Flowers, First Reserves, Goldentree, Highfields, Goldman Sachs, Farallon.
- Numerous law firms have been active in this space, notably Cadwalader, Wickersham & Taft LLP, Conyers Dill & Pearman in Bermuda and Fried Frank, Wilkie Farr, Dewey & LeBoeuf, Debevoise & Plimpton, and others in the US and UK.
Section 2.9

Securitization of Insurance Liabilities

There are two approaches to securitization of insurance liabilities:
1. Exchange-traded options on the aggregate losses of a portfolio of risks
2. Bonds with coupon and principal based on aggregate losses of a portfolio of risks.

For the first approach, we briefly describe the catastrophe insurance options traded at the CBOT based on the pamphlet PCS Catastrophe Insurance Options [36], and we use the bonds described by Tilley [197] to illustrate the second. The trade press reports other approaches, such as borrowing agreements triggered by aggregate losses in a portfolio. However, these two examples are adequate to illustrate the actuarial and financial principles needed for liability securitization.

SECTION 2.9.1 | INSURANCE OPTIONS

In May 1990 the Chicago Board of Trade announced a novel insurance futures and option complex. It provided insurance companies with a hedge against their insurance risk, and it provided investors an opportunity to profit from insurance risk. One of these, a contract based on catastrophe insurance, was moderately successful. In September 1995, the CBOT replaced the insurance contract by a better design, called PCS catastrophe insurance options. PCS stands for Property Claim Services, an independent company to which the industry reports claims. The contracts behave like property catastrophe stop-loss reinsurance on a portion of the industry’s property risk in a region of the U.S.

To illustrate this, consider a hypothetical insurance company that has sold property insurance in Florida. Let \( X \) denote the aggregate loss that the company incurs during the period \((t, T)\). Consider a stop-loss reinsurance policy covering \( m - d \) in excess \( d \). The reinsurer’s payment \( f(X) \), which we discussed in Section 2.7, can be written as

\[
f(x) = (x - d)^+ - (x - m)^+.
\]

(We leave the verification of this relation as an exercise.) Thus, the reinsurance contract has the same mathematical structure as a portfolio of two call options (one long with exercise price \( d \) and one short with exercise price \( m \)). If call options were written on the insurance company’s losses, the reinsurance payment could be duplicated with two calls. A portfolio of two call options created in this way is a call option spread. A CBOT option spread has exercise values, which are analogous to reinsurance payments. In 1996 the CBOT offered spread contracts, whereas in early 1997 it offered only call
options. Of course, a trader can construct a spread as we just described, so it may be less complicated and just as useful to offer only call options.

However, the CBOT insurance options are not the same as options on assets, such as stocks and bonds, because the underlying insurance is not traded. Moreover, the insurance options differ from traditional reinsurance in that they are written on the industry's portfolio, not the portfolio of a single company. We must keep these issues in mind when using CBOT options as reinsurance. In addition, reinsurance is not easily traded, and reinsurance contracts are customized and nontransferable. The CBOT options are easily traded, and they are not customized. Moreover, as mentioned earlier, reinsurers provide expertise and services, such as underwriting, as well as the promise to pay.

The CBOT options are written on nine loss ratios calculated by Property Claim Services. Thus, the underlying "asset" on which the options are written is not an asset at all: it is the loss ratio on a specific set of insurance policies. An insurance company would have to know the correlation of its own policies with those underlying the index loss ratio to use the CBOT options as a hedge. Although it may require some effort and the hedge is not perfect (as reinsurance is), an insurance company might buy call spreads if they were cheaper than reinsurance.

The CBOT has been careful to point out to insurance regulators and customers that it is not an insurance company. It merely aligns buyers and sellers.

If insurance companies are the natural buyers of call spreads, who are the sellers? The CBOT points to statistical studies that show that the underlying loss ratio is not correlated with the stock market (see Froot et al. [67] and Lane [117]). It suggests that investing in catastrophe options diversifies the investor's portfolio in a way that is difficult to do with stocks; that is, selling catastrophe call options should provide returns that, on average, are not correlated with returns on stocks.

This may be better than simply buying shares in a reinsurance company. Selling catastrophe options has lower transaction costs than buying reinsurance shares. It is more of a "pure" play in that it concentrates on catastrophe risk, whereas a share of a reinsurer provides a claim on all earnings of which catastrophe business may be a small portion. All of these are reasons investors such as life insurance companies and pension funds might invest in insurance options or other insurance derivatives.

We now turn to the details of the PCS option contract, following the CBOT pamphlet [36]. The underlying index is one of the following PCS loss indices: National, Eastern, Northeastern, Southeastern, Midwestern, Western, Florida, Texas, and California. Each PCS loss index reports PCS estimates for insured industry losses resulting from catastrophic events in the area and loss period covered. PCS provides each index daily. Each PCS loss index represents the sum of then-current PCS estimates for insured catastrophic losses in the area and loss period covered divided by $100 million.
The loss period is the time during which a catastrophic event must occur in order for resulting losses to be included in the index. The California and Western indices have annual loss periods; other indices have quarterly loss periods. The development period is the time after the loss period during which PCS estimates continue to affect the PCS indices. PCS option users can choose either a 6- or a 12-month development period. The PCS index value at the end of the chosen development period is the settlement value. The length of the development period is important because it can take many months to settle losses after an earthquake or hurricane.

Option premiums are quoted in points and tenths of a point. Each point equals $200, and so each tenth of a point equals $20; for example, a premium of 5.2 equals $1,040. All PCS options, which are European style, expire at 6:00 p.m. on the same day in which the settlement value of the underlying index is made publicly available, either 6 or 12 months after the loss period, depending on the development period of the option. For catastrophe insurance options, the buy/sell obligations settle in cash, like options written on stock-price indices. For the stock-price index options, the underlying index is widely disseminated and independently calculated. The PCS loss index plays the same role for catastrophe insurance options that the stock price index plays for stock index options.

Information about claims payments is very important to catastrophe insurance options traders. This may not be available to all traders, but daily catastrophe loss information is available from Property Claims Service. Of course, catastrophic events such as hurricanes also have an impact on option prices. We expect catastrophe insurance option prices to vary daily just as the more familiar futures prices of commodities and financial instruments do, even though the financial press does not publish actual loss data.

PCS options can help insurers and reinsurers protect their book of business against catastrophic losses. PCS options can act as a complement to traditional reinsurance, filling in the gaps when traditional coverage either is not available or costs too much. As an example, consider this report from the financial press during the week of March 29, 1996. Ten of the third-quarter Southeastern 200/250 call spreads sold for 1.8 points. This means there was a trader willing to buy and another trader was willing to sell at

\[ 1.8 \text{ points} \times 200 \text{ per point} = 360 \text{ per contract}. \]

The option provides protection for the index values between

\[ 200 \text{ points} \times 100 \times \text{ million per point} = 20 \text{ billion} \]

and $25 billion. The index reflects industry losses in the Southeastern region incurred during July, August, and September 1996 and settled during the 12 months following
September 1996. If the index settles below 200, the call option pays the owner nothing. If it settles at or above 250, it pays

\[(250 - 200) \times $200 = $10,000.\]

For an index value \(I\) between 200 and 250, it pays \((I - 200) \times $200\).

Thus, the call spread represents a fraction of a stop-loss reinsurance on the industry’s Southeastern region exposure, covering $5 billion of losses in excess of $20 billion, incurred during the third quarter and settled within 12 months. In October 1996 the index was 16.4, corresponding to industry losses of $1.64 billion. The option was well out of the money at the end of the loss period. Loss development will probably not move the index into the money by September 1997, when the contract settles.

If an insurance company’s loss exposure is 0.1% of the industry’s exposure in the Southeastern region during the third quarter, then the 200/250 index spread corresponds to company losses in the range of $20 million to $25 million. The company might use the call spread as a substitute for stop-loss reinsurance of $5 million in excess of $20 million. One option pays zero to $10,000 over this range, so 500 contacts would cover zero to

\[500 \times $200 \times (250 - 200) = $5\text{ million}.\]

The company would need to buy 500 contracts at a cost of

\[500 \times $360\text{ per contract} = $180,000\]

to “cover” this exposure. Of course, it is not a perfect substitute for traditional reinsurance because the call spread is written on the industry’s portfolio instead of the company’s own loss exposures.

As appealing as the PCS options may seem, they clearly have a long way to go before they can be a competitive threat to traditional reinsurance. In March 1996, there were only about 2,800 outstanding insurance options; this is the open interest. By October 1996, this had increased to about 6,800. In comparison to other option markets, this is low volume. On the same date, the volume of options on U.S. interest rate futures exceeded 50,000, and there were more than 24,000 options on crude oil futures.

In summary, an insurance company might buy catastrophe call spreads as a substitute or supplement to traditional reinsurance. An investor or a reinsurer might sell call spreads if the prices were attractive. The risk of writing call spreads is very similar to the reinsurer’s risk in writing traditional coverage on a proportion of the industry.
SECTION 2.9.2 | CATASTROPHE REINSURANCE AS A HIGH-YIELD BOND

Most investment banks, some insurance brokers, and most large reinsurers developed OTC insurance derivatives by 1995. This is another form of liability securitization, but instead of exchange-traded contracts, these securities are handled like private placements or like forwards or custom options. Tilley [197] describes securitized catastrophe reinsurance in terms of a high-yield bond. Froot et al. [67] describes a very similar one-period product. These products illustrate how catastrophe risk can be distributed through capital markets. The description here is an abstraction and simplification; refer to the literature provided by the product developers for practical details.

Consider a reinsurance contract issued at \( t \) for which the reinsurer agrees to pay a fixed amount \( L \) at \( T > t \) if a defined catastrophic event occurs. It pays nothing if there is no catastrophe. \( L \) is known when the policy is issued. If \( q_{\text{cat}} \) denotes the probability of a catastrophic event and \( P \) the price of the reinsurance, then the "fair" value of the reinsurance is

\[
P = \frac{1}{1 + i_f} L q_{\text{cat}}
\]

where \( i_f \) is the risk-free effective interest rate over the policy period. This defines a one-to-one correspondence between bond prices and the probability of a catastrophe. Because the reinsurance market will determine the price \( P \), it is natural to call \( q_{\text{cat}} \) the reinsurance market assessment of the probability of a catastrophe.

From where does the capital to support the reinsurer come? The reinsurer will have no customers unless it can convince them that it has capital at least equal to \( L \). Suppose that just before it sells the reinsurance, the reinsurer borrows capital by issuing a defaultable bond. "Defaultable bond" is a fancy term for junk bond, a bond with a relatively high risk of default. Investors know when they buy a junk bond that it may default, but they buy it anyway because the bonds do not often default and they have higher returns than more reliable bonds.

The reinsurer issues enough bonds to raise an amount of cash \( C \) determined so that

\[
(P + C)(1 + i_f) = L.
\]

This satisfies the reinsurer's customers: they see that the reinsurer has enough capital to pay for a catastrophe. The bondholders know that the bonds will be worthless if there is a catastrophe, in which case they get nothing. If there is no catastrophe, they get their cash back plus a coupon \( R = L - C \).
The bond market will determine the price per unit of face value. In terms of discounted expected cash flow, the price per unit can be written in the form

\[
\frac{1}{1 + i_f}(1 + c)(1 - q_B)
\]

where \( c = R/C \) is the coupon rate and \( q_B \) denotes the bondholders' assessment of the probability of default on the bonds. We can assume that the investment bank designing the bond contract sets \( c \) so that the bonds sell at face value. Thus, \( c \) is determined so that investors pay 1 to receive \( 1 + c \) a year later, if there is no catastrophe. This is expressed as

\[
1 = \frac{1}{1 + i_f}(1 + c)(1 - q_B).
\]

Of course, default on the bonds and a catastrophe are equivalent events. The probabilities \( q_B \) and \( q_{cat} \) can differ because bond investors and reinsurance customers can have different information about catastrophes. The reinsurance company sells bonds once \( c \) is determined to raise the required capital \( C \). The corresponding bond market probability is found by solving for \( q_B \):

\[
q_B = \frac{c - i_f}{1 + c},
\]

and the implied price for reinsurance is

\[
P_B = \frac{1}{1 + i_f} \frac{c - i_f}{1 + c} L.
\]

Provided the reinsurance market premium \( P \) (the fair price determined by the reinsurance market) is at least as large as \( P_B \), the reinsurance company will function smoothly. It will collect \( C \) from the bond market and \( P \) from the reinsurance market at the beginning of the policy period. The sum invested for one period at the risk-free rate, \((P + C)(1 + i_f)\), will be at least \( L \), so the reinsurer has adequate capital. This is easy to see mathematically using the relation \( R = L - C \).

So long as \( P_B \) does not exceed \( P \), or equivalently, so long as

\[
q_{cat} \geq \frac{c - i_f}{1 + c},
\]

an economically viable market will exist for reinsurance capitalized by borrowing in the bond market. In an efficient market with infinite capacity, the inequality would be expected to become an equality. However, these catastrophe products have been developed in response to limited reinsurer market capacity.
Borrowing (issuing bonds) to finance losses is not new. In the late 1980s when U.S. liability insurance prices were high and interest rates were moderate, some traditional insurance customers switched to self-insurance programs financed by bonds. Tilley [197], Froot et al. [67], and others imply that the same price relation between the catastrophe property reinsurance market and the bond market exists in the 1990s.

In summary, the reinsurer has adequate cash to pay the loss if a catastrophic event occurs. If no catastrophe occurs, the fund goes to the bond owners. From the bond owners’ perspective, the bond contract is like lending money subject to credit risk, except the risk of “default” is really the risk of a catastrophic event. Note that the reinsurer has adequate cash at the beginning of the period to make the loss payment with probability one. Tilley describes this as a fully collateralized reinsurance contract.

This scheme is a simple version of how a traditional reinsurer works with these differences. The traditional reinsurance company investors buy shares of stock instead of bonds. Losses are based on a portfolio of risks rather than single exposure. Simplifying and specializing makes it possible to sell single exposures through the capital markets, in contrast to shares of stock of a reinsurer, which are claims on the aggregate of outcomes. Tilley [197] demonstrates this technique in a more general setting in which the reinsurance and bond are multiperiod contracts. This one-period model illustrates the key ideas.

“Insurance securitization”: one of many sets of financial risk management (FRM) tools. Defined as the transferring of underwriting risks to the capital markets through the creation and issuance of financial securities. Involves the following two elements:
- Transformation of underwriting cash flows into tradable financial securities (financial engineering).
- Transfer of underwriting risks to the capital markets through the trading of those securities.

Securitization in historical perspective:
- MBS: Late 1970s excess mortgage demand pushed for creation of mortgage derivatives. Players in this:
  - Borrower (homeowner),
  - Loan originator (bank),
  - Special Purpose Trust,
  - Underwriter (investment bank),
  - Investors (capital markets).
- Benefits: enhanced liquidity, ability to determine market value of loans, lower cost of moving funds from investors to borrowers, improved credit rating.
- ABS: David Bowie, auto loans, credit cards.

Funding shortfall has been suggested as the critical issue, starting the process.

Evolution of insurance securitization:
Insurance securitization viewed initially as a threat by insurance professionals. Then a “portfolio” concept developed, packaging of insurance and financial risks. DFA caused actuaries to identify sources of risk:
- Underwriting
- Loss experience -- frequency and severity
- Underwriting cycle -- premiums and profitability
- Inflation
- Payout patterns
- Catastrophes
- Investment
- Interest rate risk
- Capital market performance

Initial focus of insurance securitization has been on catastrophe risk.

In a greater scheme of things, securitization is a part of FRM. Then the natural question is: does the method of financing affect the value of the firm? If Modigliani-Miller fully applies, the all this financial engineering does not make any sense. But MM makes assumptions, and if they are violated, financing matters. If FRM matters then it is through:
- Tax effects (convex tax function: more volatile earnings cause higher tax)
- Financial distress/bankruptcy costs
- Effect on future investment decision (K.O.: or, agency costs in general)
Why insurance securitization now?
- Recent catastrophe experience (Hurricane Andrew in 1992, Northridge earthquake in 1994, losses in tens of billions of dollars, problems of Lloyd’s).
- Capital market developments (hungry for new investment alternatives, high yield with diversification benefits very desirable).
- Structure of the insurance industry (mergers, acquisitions, consolidations).

Reasons typically given for securitizing insurance risk
- Capacity (P&C capital $250 billion, capital markets have greater capacity to absorb risk).
- Investment (Catastrophe risk is uncorrelated with capital markets, diversification benefits).

Capacity issue is equivalent to funding shortfall in the mortgage industry. Is it really true?
Three points:
- Industry built up its net worth to address future catastrophes.
- Insured loss is certainly smaller than the entire catastrophe loss.
- New capital enters the industry when rates of return are high.

In addition to “capacity” and “zero-beta” arguments (which are debatable) one must consider:
- Understanding (by both sides of the trade)
- Functional separation (historically, insurance and finance have been separated, even as a function within a P&C company)
- Information and technology
- Difficulty in pricing
- Cost
- Legal/tax/accounting issues (if you buy an insurance derivative, are you an insurer, and must you register in 50 states, including New York for life insurance, or worse yet, Massachusetts for auto insurance?)

Types of insurance securitization
- Those that transfer risk
  - Reinsurance: transfers risks to other companies within the insurance industry.
  - Swap (including risk exchanges): transfers risks to other insurers (or to the capital markets).
  - Catastrophe bond: transfers risks to the capital markets.
  - Exchange-traded derivative: transfers risks to the capital markets.
- Those that provide contingent funding
  - Line of credit: right to borrow.
  - Contingent surplus note: option to borrow contingent upon the occurrence of an event.
  - Typically, funds are placed in a trust and invested, say, in T-bills. In the event of a catastrophe, the insurer can use those funds, replacing them with surplus notes.
  - Catastrophe equity put: option to sell equity (usually preferred shares) at predetermined terms, contingent upon an event.
Chicago Board of Trade (CBOT) catastrophe option spreads
- European cash options – in other words, they are settled only at the expiration of the contract, in cash, (6 or 12 months after the end of the loss period).
- Loss periods are calendar quarters, except for Western States and California options, which are annual (based on the assumption that earthquake risks are not seasonal).
- Estimates of aggregate industry catastrophic losses are made daily by Property Claim Services (PCS); in the form of an index.
- Each index point is equivalent to $100 million of aggregate industry catastrophe losses. The cash value of each index point, in terms of the settlement value of the option, is $200. Strike values – the values, which identify the parameters of the option and determine whether the option is in or out of the money – are in multiples of 5. The tick size (trading interval) is one-tenth of a point (thus, $20).
- There are nine different instruments available from a geographic perspective, including three individual states and five regional state groupings:
  - National: All states + DC
  - Eastern: AL, CT, DE, DC, FL, GA, LA, ME, MD, MA, MS, NH, NJ, NY, NC, PA, RI, SC, VT, VA, WV
  - Northeastern: CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT
  - Southeastern: AL, FL, GA, LA, MS, NC, SC, VA, WV
  - Midwestern: AR, IL, IN, IA, KS, KY, MI, MN, MO, NE, ND, OH, OK, SD, TN, WI
  - Western: AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY
  - California
  - Florida
  - Texas.

CBOT options work like excess reinsurance
Suppose a December 30/50 Texas call option spread has been purchased by an insurer which has property exposure in that state. This option spread is analogous to a $2 billion in excess of $3 billion layer on fourth-quarter aggregate industry catastrophe losses in Texas, since

$50 - 30 \cdot \$100 million = \$2 billion,$

and

$30 \cdot \$100 million = \$3 billion.$

Financially, the excess nature of the spread is accomplished by buying a call option with an exercise price of 30, and selling an option with an exercise price of 50. This buy-sell combination is built into the spread. If fourth-quarter Texas catastrophe losses to the industry amount to $4.5 billion, the company that purchased this option spread would receive $3000:

$\left( \frac{$4.5 \text{ billion}}{\$100 \text{ million}} - 30 \right) \cdot \$200 = \$3000.$

For those CBOT contracts that involve spreads of twenty index points (a very common spread size), the most that any one spread can pay to its purchaser is $4,000 (20 points multiplied by $200 per point). Large volume of spreads must be bought in order to
provide an effective hedge. Exhibit 1 in the reading shows the actual volume of this instrument, it has been disappointing.

**Catastrophe options** on the Bermuda Commodities Exchange (BCOE). Basic concept underlying these options is the same as that for CBOT PCS options. There are some differences:

- The trigger is based on the Guy Carpenter Catastrophe Index, paid homeowners losses divided by housing values. Values for the index are available as finely as by zip code, and are updated quarterly. The index reflects homeowners loss experience of companies (representing about 25% of homeowners premiums) reporting to ISO.
- The geographic contracts available include National, Northeastern, Southeastern, Gulf, and mid-Western/Western states, Florida, Texas.
- Three different types of catastrophe options are available – single loss (largest catastrophic event during a period), secondary loss (the second largest event), and aggregate catastrophe.
- The risk periods underlying the options are semi-annual: either the first-half or the second-half of the calendar year.
- The BCOE options are “binary options.” Specifically, the options pay off either $0 or $5,000 at expiration -- there is no intermediate value possible (as there is with CBOT options).
- The value of the index is determined at quarterly intervals (1, 4, 7, 10, and 13 months after the end of the risk period). At each of the above quarterly intervals (and only then), the option may or may not be settled, depending on how far below or above the strike price is the index value.

There are also **risk exchanges**
Catastrophe Risk Exchange (CATEX) New York is a computer-based trading exchange that allows subscribers to swap their catastrophe exposures. Thus, subscribers can adjust their risk distribution profiles -- by geographic location and/or by property type -- by trading written exposures. Risks available for trade can be “advertised” on the electronic system, where trades can be negotiated and completed. Reinsurance can also be purchased.

CATEX (Bermuda) in a joint venture with the Bermuda Stock Exchange. This offshore exchange provides a mechanism for exchanging or purchasing of risks, and is open to insurers, brokers, and capital market investors.

**Catastrophe equity puts:** form of contingent financing. An agreement is entered into whereby the insurer, in the event of a catastrophe, has the right to sell equity (usually preferred stock) to investors at a pre-specified price.

**Catastrophe bonds**
The trigger issue: securitized product’s ability to hedge catastrophe risk depends on the type of “trigger” used (trigger is the event that causes the payoff of the instrument to be
adjusted). Two risks: basis risk, moral hazard. Note that basis risk and moral hazard of design are inversely related. Types of triggers:

- Direct: the contingency upon which the payoff of the instrument depends is based on the company’s losses. Example: USAA bond offerings, in which principal and/or interest payments are adjusted in the event of a loss in excess of $1 billion to the company from a category 3 or higher hurricane. With a direct trigger, there is no basis risk, since the payoff on the hedging instrument depends upon the company’s own losses, rather than those of the industry as reflected by an index.

- Industry: payoffs depend upon overall industry loss experience, as reflected by an index. Examples: Swiss Re California earthquake bond, and the CBOT PCS options. With an industry trigger, there is little or no moral hazard (in theory there could be some, since the company’s loss experience may impact the value of the index), but basis risk can be significant. This is because the loss experience underlying the index may not match the loss experience of the company, and so the instrument would provide an imperfect hedge.

- Event: payoffs depend upon the occurrence of a defined event. Example: Tokio Marine & Fire bond which has as its trigger an earthquake that registered 7.1 or more on the Japanese Meteorological Association scale. Potentially, an event trigger can involve significant basis risk, since the “payoff” of the bond is not based on the company’s actual losses, nor even on the industry’s losses, but on the occurrence of an event.

Types of risk taking

- In catastrophe bond, there must be a structure for the investor to take risk. Interest and/or principal payment obligations of an insurer under a catastrophe bond are affected by the occurrence or non-occurrence of a certain level of catastrophic loss. From the investor’s standpoint, depending upon the “tranche” invested in, there is the risk of losing some, or all, of the principal invested, and/or the risk of diminished or lost interest. Some tranches may have higher, some lower protection.

- Typical issuance structure: analogous to MBS. Typically, an insurance company sets up a Special Purpose Vehicle (SPV) to act as an “intermediary” between the company and the capital markets. Generally, the SPV is an offshore reinsurer; this structure is used to maintain favorable tax and accounting treatments. The SPV issues a reinsurance contract to the company; in turn, the company issues bonds to the capital markets through the SPV. The SPV pays the cash flows on the bonds (and funds the reinsurance protection) from the reinsurance premiums paid by the company, and from the invested bond proceeds.

- Offerings:

  There have been unsuccessful ones (ACE, California Eartquake Authority). Possible reasons for failures: newness, uncertainty regarding prices, portfolio issues, competition from traditional reinsurance. But there have been some successes: Hanover Re for Japanese quakes and international storms, Reliance, Wintherthur. Traits common to successful offerings:

  - Highly volatile catastrophic risk
  - Relatively high levels of protection
  - Relatively short maturities (except, for example, the Japanese issues)
- Some protection of principal is included
- High coupon rates (although the 1998 USAA bond discussed above suggests that the coupon rates have already begun to diminish)

• Costs of catastrophe bonds
  - Must offer high yields
  - Must set up Special Purpose Vehicle

The future of insurance securitization
- Will insurance securitization in general, and property/casualty securitization in particular, survive and grow?
- Will securitization products replace or supplement traditional transactions?
- How will securitization affect reinsurance?
- Will “capacity” continue to be given as a significant reason for securitization, or will other issues and concerns come to dominate?
- Will volatile catastrophe risks continue to be the focus of securitization products, or will future instruments contemplate more traditional insurance lines?
- Are securitization instruments “insurance”? 1998 Bermuda Insurance Amendment Act said “no”: insurance derivatives are “investment contracts,” not insurance.
- What are the different tax and accounting implications of the various instruments?
- What form will insurer financial risk management take in the future?

Review Appendix 1: Summary of Recent Successful Securitizations – although questions requiring memorization of these are next to impossible to expect. In fact, the pattern of questions about this reading is clear, as questions were asked about it frequently, see below.

**Exercise 1**
You are in charge of hedging the property-casualty loss exposure at your company using the Property Claims Service options (actually spreads, which consist of a long call of lower exercise price, and short call of a higher exercise price). The premium for the spreads is quoted in points, and each point is worth $200. Suppose that you are given that the 200/250 spread provides protection for the underlying index values at the rate of $100,000,000 per point, and the spread acts like a long 200 points call combined with short 250 points call, with the actual payment equal to number of points times $200. You have bought 500 contracts, and the index settled at $25 billion. What is the payoff to your company?

Solution.
$25 billion corresponds to
\[
 \frac{25,000,000,000}{100,000,000,000} = 250 \text{ points}
\]
You have a 200 call, which is now worth 50 points, or 50 times $200 = $10,000, and you are short a 250 call, which expires worthless. Thus your payoff is $10,000 per contract, or $5,000,000 for 500 contracts.
Casualty Actuarial Society May 2004 Course 8 examination, Problem No. 35
If financial risk management can theoretically add value to a firm, it must do so through violations of one or more of Modigliani and Miller’s assumptions in the formulation of their irrelevance propositions. Explain two of the three assumptions that might be violated and, for each, how financial risk management could add value to a firm.

Solution.
Three key areas: reduction of bankruptcy/financial distress costs, reduction of tax expenses, reduction of agency costs.
1. Reduction of bankruptcy/financial distress costs: FRM can help avoid financial distress. Bankruptcies are costly, and so is financial distress (firm is unable to raise capital and may choose suboptimal investment strategies if in distress).
2. Reduction of tax expenses: Progressive tax code means that less volatile earnings result in smaller expected tax expense, thus FRM can add value by reducing taxable income volatility.
3. Reduction in agency expenses: There is a variety of examples here, such as:
   a. If a firm suffers large losses, managers are likely to act suboptimally, either pursuing a low-risk or high-risk strategy (depending on whether it makes sense for them to protect their jobs, or go for broke), thus wasting owner’s resources.
   b. FRM can help align managers’ and owners’ incentives.

Casualty Actuarial Society May 2003 Course 8 examination, Problem No. 35
It has been four years since Gorvett’s “Insurance Securitization: The Development of a New Asset Class” appeared in the CAS discussion paper program on securitization of risk. While some insurance securitization has occurred, the interest has not developed into widespread utilization. Based on the paper, briefly explain two reasons why utilization may not have been widespread.

Solution.
The key reasons given for promotion of insurance securitization have been:
- diversification effect for investors (especially the “zero beta” argument claiming that insurance derivatives are uncorrelated with the stock market or the bond market), and the need for capital in the reinsurance industry. But Gorvett states that
  1. Reinsurance industry does not appear to be undercapitalized.
Furthermore,
  2. The diversification benefits may not be all that they were promised to be. After all, catastrophic losses may affect the stock market.
In addition to that, Gorvett points out that
  3. Issuing insurance derivatives is costly, because of expertise required, and legal and regulatory issues. Investors may also be unfamiliar with them, causing relatively high return expectation.
Finally,
  4. There is significant uncertainty about pricing of insurance derivatives.
Casualty Actuarial Society May 2002 Course 8 examination, Problem No. 12

Answer the following according to Gorvett, in “Insurance Securitization: The Development of a New Asset Class.” You have been asked to evaluate a proposal for securitizing terrorism risk.

a. State two primary reasons cited by Gorvett in favor of securitizing insurance risk and briefly discuss whether each is valid in the case of terrorism securitization.

b. Identify and describe the three triggers Gorvett identifies that might be used in an insurance securitization arrangement.

c. Gorvett identifies two risks that may exist depending upon the type of trigger utilized. Identify and briefly describe these risks.

d. For each trigger in b., briefly discuss how each of the risks identified in c., may or may not apply for securitizing terrorism risk.

Solution.

a. Two reasons given are: capacity (need for capital in the insurance/reinsurance industry) and investment (diversification benefits for investors). Terrorism can cause catastrophic losses, significantly impacting industry capital, so the capacity reasoning makes sense. Diversification argument is debatable, as a large terrorist attack will affect the stock market negatively. But one could also argue that terrorist plans are uncorrelated with financial markets.

b. Direct trigger: payment based on insurer’s own losses.
Industry trigger: payment based on industry losses.
Event trigger: payment based on the occurrence, or occurrence and financial measurement, of a specific event.

c. Basis risk: risk of divergence between insurer’s losses and the index used for reinsurance payoff.
Moral hazard: once an insurer acquires reinsurance, less incentive to control risk and reduce losses.

d. Direct trigger has no basis risk and significant moral hazard. Always, not just for terrorism losses.
Industry trigger has almost no moral hazard, and significant basis risk.
Event trigger has no moral hazard, but the highest level of basis risk.
Example: terrorists hit one large building insured by one company. This will not have much effect on the entire industry, and may not activate industry trigger. It is also unlikely to cause an event trigger, unless the building is very significant in the national economy, but then it its unlikely it will be insured with one company. The moral hazard is indicated in noting that if the reinsurance uses a direct trigger, the ceding insurer has little incentive to seek strong security protections for the building, but in the case of industry trigger or event trigger, such incentive is very significant.
Casualty Actuarial Society May 2001 Course 8 examination, Problem No. 44
Based on Gorvett’s “Insurance Securitization: The Development of a New Asset Class,” answer the following:
a. Why would investors be interested in adding an insurance derivative to their portfolios?
b. Capacity is generally given as a primary reason for securitizing insurance risks. Gorvett, however, argues that a capacity shortfall may not exist in the property and casualty industry. Identify two points to support Gorvett’s argument.

Solution.
a. The key argument is the diversification argument, especially the “zero beta” claim that insurance derivatives returns will be uncorrelated with the stock market or bond market.
b. Insured losses may be much less than the actual property damage. Insurance and reinsurance industries have accumulated capital for the purpose of funding possible catastrophic losses, at least that is the stated purpose of the capital from the regulatory perspective. If new capital is needed, it can be provided by new entrants in the industry, and by existing firms acquiring new capital.

Casualty Actuarial Society May 2001 Course 8 examination, Problem No. 45
Answer the following based on Gorvett’s “Insurance Securitization: The Development of a New Asset Class.”
a. Your company has purchased a 20/40 call option. Describe the basis risk associated with this purchase.
b. An investor has purchased a catastrophe bond. Describe the moral hazard risk faced by the investor associated with this purchase.

Solution.
a. Basis risk is the risk that the company losses will not track those calculated in the index underlying the derivative purchased.
b. The company whose losses are covered by this derivative may not take enough precautions to avoid losses, or overstate them once they happen, once the reinsurance protection is provided by the catastrophe bond purchased by the investor.
INSURANCE SECURITIZATION:
THE DEVELOPMENT OF A NEW ASSET CLASS

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**Biography**

Rick Gorvett is an Assistant Professor of Finance and Insurance at The College of Insurance in New York. He received a BS in Mathematics from the University of Illinois at Chicago, an MBA in Finance and Econometrics from the University of Chicago, and a Ph.D. in Finance and Insurance from the University of Illinois.

At The College of Insurance, Rick teaches undergraduate and graduate courses in insurance, financial management, and financial risk management. Prior to coming to The College of Insurance, he was on the faculty of the University of Illinois Department of Finance, where he taught insurance, risk management, investments, and corporate finance. Rick’s background includes business experience as an actuary and a consultant, and he continues to consult in the actuarial area. Specific research and consulting interests include dynamic financial analysis, insurance securitization, and the use of financial models in determining insurance rates.

Rick is a Fellow of the Casualty Actuarial Society, a Member of the American Academy of Actuaries, and has the Associate in Risk Management designation.
Abstract

This paper provides an introduction to the insurance securitization process and its products. Insurance securitization is considered within a broad context, both as a subset of financial securitization, and as one of many sets of financial risk management tools available for use by insurers. A definition of insurance securitization is presented, and a description of the evolutionary process which securitization -- both insurance and non-insurance -- has undergone is provided. The factors that have led to the development and expansion of insurance securitization are discussed and examined, and various securitized products are described. Particular attention is paid to several recent successful catastrophe bond offerings, which have received significant publicity. The paper concludes with a discussion of the future of insurance securitization.
1. Introduction

The concept of “insurance securitization” originated with an article published some twenty-five years ago, in which insurance derivatives (specifically, reinsurance futures) were first speculated upon. Interestingly, this article appeared even before the word “securitization” was first coined by the financial markets, and it was only later in the 1970s that non-insurance securitized products -- in the form of asset-backed (specifically, mortgage-backed) securities -- began to be traded. Since that initial activity, it has taken nearly twenty years for insurance securitization to become a practical reality.

Throughout this paper, “insurance securitization” is treated, not as an isolated process in conflict with other techniques, but rather as one of many sets of financial risk management (FRM) tools. In order to better understand the evolution, current state, and future developments of insurance securitization products -- products which have the potential, like many financial instruments, to become rather complicated -- it is also important to consider securitization in terms of a broad financial and corporate framework. If actuaries and other insurance industry personnel are to make the best use of these instruments and concepts, it is critical that they understand the wider perspective, and become comfortable with the language of finance and financial risk management.

The format of the paper is as follows. Section 2 defines our subject, “insurance securitization,” in broad terms. Section 3 places securitization in its historical non-insurance and financial perspective, and briefly reviews the evolution and structure of non-insurance securitization products. Section 4 discusses the evolution of insurance securitization as a financial risk management tool, the factors which have accompanied its introduction, and the reasons typically given for its recent development. Section 5 describes some of the more important securitization products which have been introduced. Section 6 focuses on the recent catastrophe bond issues, and includes an appendix which identifies some characteristics of several of the more significant products.  

1 Goshay and Sandor (1973).
issues. Section 7 concludes with some thoughts regarding the future of insurance securitization. Finally, the paper includes a bibliography, and a glossary of financial risk management terms. (While not every item listed in the bibliography is specifically referenced in this paper, many of these sources served as background for the material covered here, and the reader may wish to refer to them for additional information and insights into insurance securitization and financial risk management.)

2. A Definition of Insurance Securitization

“Insurance securitization” can be defined as the transferring of underwriting risks to the capital markets through the creation and issuance of financial securities. In particular, the insurance securitization process involves the following two elements:

- The transformation of underwriting cash flows into tradable financial securities.
- The transfer of underwriting risks to the capital markets through the trading of those securities.

The first element might be identified as “financial engineering,” which is essentially the bundling and/or unbundling of cash flows into new and different financial securities. This is a common practice in the financial markets -- examples include Treasury strips or “zero-coupon bonds” (which essentially involve stripped-apart bond coupon and principal payments which are reconstructed into single-cash-flow securities), and collateralized mortgage obligations (involving the unbundling and re-bundling of cash flows on mortgages). The second element of insurance securitization involves the ultimate recipient of the traded risks. Instead of an insurance company transferring its underwriting risk to a reinsurer within the insurance industry, the risk is transferred to the broader capital markets. This is typically accomplished by the buying and selling of financial instruments whose cash flows (payoffs) are contingent upon underwriting experience. For example, with exchange-traded catastrophe options, the payoff on the option depends upon a sufficient amount of catastrophe losses being incurred by the insurance industry...
(according to a particular industry index) during a specified time period. With catastrophe
bonds, the payment of coupon interest and/or principal to the investors (bondholders) is
contingent upon the occurrence or non-occurrence of an insurance “event” (which may be based
upon an industry index, the level of catastrophe losses experienced by the company issuing the
bonds, or some other “trigger”).

3. Securitization in Historical Perspective

Although securitization is a very recent phenomenon within the insurance industry, the process
has existed in the general financial markets for some twenty years. This section describes the
origins of “securitization” in its non-insurance context.²

In the late 1970s, a funding shortfall in the home mortgage market provided the genesis for the
original securitization effort. In particular, excess demand by homeowners and potential
homeowners for mortgages -- excess relative to what thrifts and savings and loans were able to
supply -- led the financial markets to wonder whether there was a more efficient way to move
funds from the suppliers in the capital markets to the mortgage demanders. The answer was the
development of the mortgage securitization industry, in which the interest and principal
payments on groups of individual mortgages formed the backing for the cash flows of newly
created, tradable, and more liquid securities. The development of these securities and this market
facilitated the transferring of funds from investors to borrowers.

The first mortgage securitization product was issued in 1977, by the Bank of America. Around
that time, too, the word “securitization” was first coined -- although not without some initial
objection from the press, which contended that the term could not be used because it wasn’t a
proper word. Nevertheless, the term stuck, and is now deeply entrenched in the financial services
industry. Over the last twenty years, the securitization market has blossomed significantly -- with
some help from changes in the tax code and improvements in investment technology, the latter of

² A source of much information regarding the general securitization process is Kendall and Fishman (1996).
which has provided further support for the financial engineering of mortgage debt. (The proper pricing of mortgage-backed securities generally involves complex econometric models, since the cash flows of such securities are dependent upon future economic and financial developments. For example, the cash flows of mortgage-backed securities depend upon mortgage prepayment patterns, which in turn depend upon the pattern of interest rates.)

In general, the mortgage securitization process has involved the following participants:

- Borrower (homeowner)
- Loan originator (bank)
- Special Purpose Trust
- Underwriter (investment bank)
- Investors (capital markets)

These participants can be viewed as comprising two pairs -- the borrower and loan originator, and the underwriter and investors -- with an “intermediary” between the pairs. That intermediary is termed a “Special Purpose Trust,” which generally purchases the groups of individual loans from the first pair, and issues the mortgage-backed securities to the second pair. As we will see in Section 6, this same type of “intermediary” has, at least up until now, been an important part of the catastrophe bond issuance process.

The asset-backed securitization process has several benefits which have led to its popularization and expansion. One significant benefit involves enhanced liquidity: for example, non-rated and illiquid mortgage loans have been transformed into highly liquid, tradable assets. Another benefit, which flows from the securities’ tradability, is the ability to determine the market values of loans. In addition, securitization provides a more efficient and lower cost way of moving funds from investors to borrowers. Given these and other benefits, an additional advantage is the possibility of an improved credit rating.
The original mortgage-backed securities have now been joined by other types of asset-backed securities -- e.g., the packaging of auto loans, and credit card receivables. Other asset-backed securities that are more unusual and innovative have also been either proposed or issued: the future sales on David Bowie’s record albums, and debt issued by the National Football League. (The latter was an intended 10-year, $600 million debt offering that would have been largely supported by the recent $18 billion television agreement signed by the NFL; however, this debt issue was subsequently withdrawn, at least partially because the term of the debt exceeded the term of the NFL’s television agreement that was going to be used to support the issue.)

Insurance securitization, then, is a step in the evolution of the general securitization process. When considering insurance securitization’s future, it is interesting and instructive to compare the specific characteristics of the insurance industry with those financial sectors that have already proven amenable to securitization. For example, the existence of a “funding shortfall” in the mortgage financing market was referred to above as the primary motivation for the initial development of securitization. In fact, it has been suggested that a funding shortfall is the critical element, or the prerequisite, for having a successful securitization market in any industry segment. In Section 4, we will examine whether this “prerequisite” is fulfilled with regard to insurance securitization, or whether there are other, more important motivations. Another interesting issue involves the types of things that are securitized. Historically, the assets that have been most successfully securitized have been those that have significant volume and that are in some sense relatively “stable” -- e.g., mortgage loans, auto loans, and credit card receivables. It is interesting, then, that the insurance industry has concentrated primarily upon an extremely volatile and unpredictable process -- natural catastrophes -- in its initial securitization efforts.

4. The Evolution of Insurance Securitization
A. Institutional and Finance-Theoretical Contexts

As mentioned in Section 1, it is instructive to put insurance securitization into a broad context, both historically and financially. For example, when insurance securitization was originally proposed -- and to some extent even now, after several years of development -- it was looked upon as a threat to “traditional” insurance. If looked at in strict isolation, that opinion is somewhat understandable. However, in a broader perspective, insurance securitization is really just one in an evolutionary sequence of “affronts” to traditional insurance which are changing the nature of the industry, rather than threatening its overall existence. A decade or two ago, self-insurance and captives were considered to be significant threats to the insurance industry. Three or four years ago, insurance securitization came on the scene, and still provides similar fears. Even more recently, “portfolio insurance” has attracted interest. (Portfolio insurance involves the packaging of both insurance and financial risks -- e.g., foreign exchange risks -- into a single multi-line policy; such packaging takes advantage of the potential benefits of portfolio theory and diversification of risks.) While there is no question that the insurance industry needs to address itself to each of these -- and other -- potential “threats” to its traditional business, these developments also provide opportunities of which the industry is well-positioned to take advantage.

Actuaries are accustomed to viewing insurance risks from what might be termed an “institutional” perspective. Recent efforts in dynamic financial analysis, for example, have largely involved the identification of the sources of risk faced by property-liability insurance companies. These sources include risks on both the underwriting and investment sides of an insurer’s operations. Some examples include:

- Underwriting
Loss experience -- frequency and severity
Underwriting cycle -- premiums and profitability
Inflation
Payout patterns
Catastrophes

• Investment
  ➢ Interest rate risk
  ➢ Capital market performance

While the focus of insurance securitization has, so far, involved catastrophic risks, any of the risks above (or the others to which an insurer is subject) can prevent a company from meeting its objectives -- whether the objectives are defined in terms of profitability, solvency, liquidity, etc. Addressing risks to better enable a company to meet its objectives is the point of financial risk management and hedging. Thus, securitization, in its current incarnation and viewed as a tool of FRM, is intended to help meet an insurer’s objectives by addressing catastrophic risk.

While it is useful and instructive to view securitization as an FRM tool, such a financial perspective brings up an interesting issue. An important question in financial economics is whether financial risk management techniques can actually create or increase firm value. The more general form of this question is whether the method of financing a company -- i.e., the form of the right-hand-side of the balance sheet, for example equity versus debt -- can affect the value of a company. In 1958, Modigliani and Miller,\(^3\) in what has become known as their “irrelevance” propositions, gave a qualified “no”: under certain assumptions, the method of financing a company cannot affect its value, because value is determined on the left-hand-side of the balance sheet. In other words, it really doesn’t matter how a company gets money in the door -- e.g., whether from issuing debt or issuing equity. Rather, what matters is how those funds are put to use -- e.g., what capital investments the company makes. If this is true, then since

\(^3\) Modigliani and Miller (1958).
financial risk management techniques involve financing, we are left with the question of whether FRM efforts are worthwhile.

The key to answering this question is in the assumptions that Modigliani and Miller made in formulating their irrelevance propositions. If financing in general -- and, for our purposes, FRM in particular -- are to impact company value, it must do so through “violations” of one or more of their assumptions. Specifically, they assumed no tax effects, no costs of financial distress, and a fixed investment policy. Thus, if FRM is to matter, it must be through one or more of the following three items:

- **Tax effects**: A convex tax function, where the marginal tax rate increases with increases in the company’s income, may cause financing policy in general, and FRM in particular, to matter. In this case, more volatile earnings will result in a higher average tax liability. Thus, FRM can add value to the firm by decreasing the volatility of the future earnings stream.

- **Financial distress / bankruptcy costs**: Highly leveraged or solvency-threatened firms may behave in sub-optimal ways, for example by favoring high-risk investments. Thus, FRM can add value by promoting better operational behavior through minimizing the costs of financial distress.

- **Effect on future investment decisions**: When a company experiences losses, it is possible that new, sound, profitable investments may be “crowded out.” The only way the company can then afford those investments is by raising external capital, which tends to be more costly than internal funds (e.g., from retained earnings). The alternative is to completely miss an important investment opportunity. Thus, FRM can add value if it can promote better capital investment behavior by reducing the potential impact of losses.

Securitization, then, as a financing and FRM tool, can theoretically add value to a firm through one or more of these irrelevance “loopholes.”
B. Why Insurance Securitization Now?

Although it has been more than two decades since insurance derivatives were first suggested, only in the last few years has a market developed for such products. Why has the evolution of insurance securitization taken so long? On the other hand, why is it happening now, rather than years in the future, if at all? The answer to these questions lies in the confluence of insurance and capital markets incidents and developments.

Three primary factors have influenced the current interest in insurance securitization:

1) Recent catastrophe experience: After significant catastrophe losses in the first half of the 1990s -- particularly Hurricane Andrew in 1992 and the Northridge earthquake in 1994 -- the industry reassessed the catastrophe risk to which it was exposed. Suddenly, it was realized that losses in the tens of billions of dollars -- or greater -- were more than theoretically possible. These catastrophes, and the accompanying attitudinal changes, had at least temporary effects on the demand for, and pricing of, reinsurance. Thus, concerns developed regarding the future availability and stability of reinsurance. (In addition, Lloyd’s of London was having problems around this time.)

2) Capital market developments: Investors and the capital markets have become increasingly mature and aggressive. The capital markets are always on the lookout for new asset classes and asset-backed markets. An ideal area for investment is one that would provide high yield with diversification benefits.

3) Structure of the insurance industry: A significant trend has been occurring recently in the insurance industry: mergers, acquisitions, and consolidations. In addition, there have been discussions regarding possible demutualizations. All of this activity suggests that the industry is becoming ever more driven by Wall Street and the financial markets.

These factors – especially the first two -- have led to two commonly accepted reasons for the existence of insurance securitization.
C. *Reasons Typically Given for Securitizing Insurance Risk*

Typically, two primary reasons are given for securitizing insurance risks:

- **Capacity:** There is a risk of huge catastrophic losses which could severely impair the capital of the property/casualty insurance industry (which is perhaps $250 billion or so). On the other hand, the capital markets, it is argued, could easily handle a loss that would otherwise amount to a significant drain on the P/C industry’s net worth. In fact, the entire net worth of the industry amounts to perhaps 1 to 2 percent of the value of the U.S. equity markets -- an amount that is not particularly uncommon any more in terms of the *daily volatility* of the stock markets. Thus, it is felt that a large catastrophic loss, while a threat to the P/C insurance industry’s solvency, could be handled without difficulty by the capital markets.

- **Investment:** If it is accepted that catastrophe exposure is uncorrelated with movements in the capital markets, then this exposure, if a way can be found to invest in it, has diversification potential. In other words, investment in catastrophic exposures -- e.g., through catastrophe bonds -- should be desired by the capital markets because it will generally be uncorrelated with existing investment portfolios. Investment in catastrophe exposures will be even more desirable if it also provides a high yield relative to the underlying risk.

While both of these reasons seem to be well-entrenched in the blossoming insurance securitization industry, one can argue with one or both of them. The zero-beta investment reason is largely an empirical issue. However, let’s look more closely at the capacity issue. In Section 3, the terminology “funding shortfall” was referred to as a possible “prerequisite” for the development of a successful securitization market. Does this apply to the insurance industry? According to the capacity argument, it does. However, *is* there a capacity shortfall in the P/C industry? Three points make the issue less than completely clear. First, one reason the industry has built up its net worth is to address future potential catastrophes. One of the purposes of surplus is to protect solvency in the event of adverse loss experience. Although it is certainly
difficult to identify how much surplus is “enough,” and the impact of a large catastrophe should always be of concern, the threat of such a loss may be within the scope of what the industry has prepared for. Second, although a large catastrophe could result in significant losses to property, the proportion of property values actually covered by insurance is low in certain places and with regard to certain coverages – e.g., earthquake and flood insurance is far from universal. Thus, the insured loss may be significantly less than the projected overall property damage. Third, as was demonstrated with regard to Bermuda catastrophe insurers after hurricane Andrew, new capital enters an industry when rates of return are high. Thus, significant losses to the industry may be only temporary, offset later by increases in rates and the entry of new insurers.

In summary, then, the capacity and zero-beta rationales for insurance securitization may be reasonable, but they beg for additional consideration and investigation. They may not be the last word.

D. Other Issues Regarding the Potential Success of Insurance Securitization

The “capacity” and “zero-beta investment” reasons for securitization are essentially factors involving the existence of securitization. Other issues, such as the following, can affect the potential future success or failure of securitization in the long-run:

- **Understanding**: To be successful, the securitization process needs to be understood by both the capital and insurance markets. Complete understanding of insurance securitization requires familiarity with the vocabulary of both markets. Without understanding, there will be skepticism.

- **Functional separation**: Historically, the insurance and finance functions in many insurance companies have been separated. The persistence of this separation will not enhance the evolutionary process of securitization.

- **Information and technology**: The capital markets will require quick and precise information in order to price and trade securities.
• **Difficulty in pricing:** While modeling techniques have advanced significantly, accurate pricing of catastrophe exposure is still extremely difficult. Further model developments, and greater comfort of investors with those models and their pricing implications, will be important.

• **Cost:** Securitized products may be perceived to be more or less expensive than traditional catastrophe insurance or reinsurance, depending upon the state of the market and the position of the underwriting cycle. (It is interesting that the current securitization products have been introduced in a relatively soft, inexpensive P/C market.)

• **Legal / tax / accounting issues:** Of course, these issues always exist. An example of a legal issue is the question of whether an investor who purchases an insurance securitization product is acting as an insurer -- and thus potentially subject to regulatory treatment as an insurer -- or as an investor.

5. **Types of Insurance Securitization Products**

There are several ways to categorize the many types of insurance-related instruments that exist or have been proposed. One approach is as follows:

- **Those that transfer risk**
  - Reinsurance: transfers risks to other companies within the insurance industry
  - Swap (including risk exchanges): transfers risks to other insurers (or to the capital markets)
  - Catastrophe bond: transfers risks to the capital markets
  - Exchange-traded derivative: transfers risks to the capital markets

- **Those that provide contingent funding**
  - Line of credit: right to borrow
  - Contingent surplus note: option to borrow contingent upon the occurrence of an event. Typically, funds are placed in a trust and invested, say, in T-bills. In the event of a catastrophe, the insurer can use those funds, replacing them with surplus notes.
Catastrophe equity put: option to sell equity (usually preferred shares) at pre-determined terms, contingent upon an event.

Many of these instruments will be described in the following sub-sections. In addition, catastrophe bonds, which have received significant recent publicity, will be discussed in Section 6.

A. Chicago Board of Trade PCS Derivatives

The insurance derivatives traded on the Chicago Board of Trade (CBOT) have undergone a significant evolutionary process. The present description will concentrate on the instruments that are currently being traded: catastrophe option spreads. These instruments began trading on September 29, 1995, and have the following properties:

- They are European cash options – in other words, they are settled in cash, only at the expiration of the contract (either 6 or 12 months after the end of the loss period).
- Loss periods are generally calendar quarters, except for Western States and California options, which are annual (on the assumption that earthquake risks are not seasonal).
- Estimates of aggregate industry catastrophic losses are made daily by Property Claim Services (PCS); the estimates are expressed in the form of an index.
- Each index point is equivalent to $100 million of aggregate industry catastrophe losses. The cash value of each index point, in terms of the settlement value of the option, is $200.
- Strike values – the values which identify the parameters of the option and determine whether the option is in or out of the money – are in multiples of 5. The tick size (trading interval) is one-tenth of a point (thus, $20).
- There are nine different instruments available from a geographic perspective, including three individual states and five regional state groupings:
  - National: All states + DC

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4 See, for example, D’Arcy, Gorvett, and France (1999).
Essentially, the CBOT options work much like excess reinsurance. An example demonstrates this analogy. Suppose a December 30/50 Texas call option spread has been purchased by an insurer which has property exposure in that state. The insurer’s purpose might be to hedge that catastrophe exposure. Essentially, this option spread is analogous to a $2 billion in excess of $3 billion layer on fourth-quarter aggregate industry catastrophe losses in Texas, since

\[ (50 - 30) \times 100 \text{ million} = 2 \text{ billion}, \text{ and} \\
30 \times 100 \text{ million} = 3 \text{ billion}. \]

(Financially, the excess nature of the spread is accomplished by buying a call option with an exercise price of 30, and selling an option with an exercise price of 50. This buy-sell combination is built into the spread.) If fourth-quarter Texas catastrophe losses to the industry amount to $4.5 billion, the company that purchased this option spread would receive $3,000:

\[ \left( \frac{4.5 \text{ billion}}{100 \text{ million}} - 30 \right) \times 200 = 3,000. \]

For those CBOT contracts that involve spreads of twenty index points (a very common spread size), the most that any one spread can pay to its purchaser is $4,000 (20 points multiplied by $200 per point). Thus a large volume of spreads must be purchased in order to provide an effective hedge. How high has the volume been on these instruments since their introduction?

\[ A \text{ good source of information is Chicago Board of Trade (1995).} \]
Exhibit 1 shows the monthly volume of trading in PCS options, and the open interest at the end of each month, through October 1998. (Open interest is the number of contracts that are still open and outstanding – i.e., the expiration date has not yet been reached and the contracts have not yet been exercised.) The data underlying these figures is provided publicly by the CBOT on their web page.\(^6\) It should be noted that the CBOT counts a trade of a PCS option as two units of volume: one on each side of the transaction. Exhibit 1 reflects this CBOT approach to counting trading activity. This exhibit shows that trading of CBOT PCS options has not involved overwhelming volume.

**B. Bermuda Commodities Exchange Catastrophe Options**

Within the realm of exchange-traded insurance derivatives, there is an alternative to the contracts available on the Chicago Board of Trade: catastrophe options are also traded on the Bermuda Commodities Exchange (BCOE). Although the basic concept underlying these options is the same as that for CBOT PCS options, there are some interesting differences in the specific characteristics of the BCOE options:

- The trigger is based on the Guy Carpenter Catastrophe Index,\(^7\) which is in the form of a loss-to-value (or damage) ratio (paid homeowners losses divided by housing values). Values for the index are available as finely as by zip code, and are updated quarterly. The index reflects homeowners loss experience of companies (representing about 25% of homeowners premiums) reporting to ISO.
- The geographic contracts available include national, northeastern states, southeastern states, Gulf states, mid-western/western states, Florida, and Texas.
- Three different types of catastrophe options are available – single loss (largest catastrophic event during a period), secondary loss (the second largest event), and aggregate cat. (Note that

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\(^6\) The web address is www.cbot.com  
\(^7\) Described, for example, in Major (1997).
the CBOT has also been intending to introduce single-event options in the fourth quarter of 1998.)

- The risk periods underlying the options are semi-annual: either the first-half or the second-half of the calendar year.
- The BCOE options are “binary options.” Specifically, the options pay off either $0 or $5,000 at expiration -- there is no intermediate value possible (as there is with CBOT options).
- The value of the index is determined at quarterly intervals (1, 4, 7, 10, and 13 months after the end of the risk period). At each of the above quarterly intervals (and only then), the option may or may not be settled, depending on how far below or above the strike price is the index value.

Perhaps the primary advantage of BCOE insurance derivatives is the potential ability to tailor an index to a company’s specific geographical exposure distribution. Rather than use an overall industry index (as do the PCS CBOT options), zip code data can be combined in appropriate ways, thus making the option payoff more consistent with the company’s own loss experience and exposure distribution. This might provide a reasonable compromise between the basis risk and moral hazard problems (see Section 6 below). The potential disadvantage is that the BCOE index is updated only quarterly, and covers only a fraction of the industry.

C. Risk Exchanges

While there are many forms that a financial “swap” can take (see Section 6.D for reference to two recent swap transactions, one within the reinsurance industry, and one to the capital markets), one example of the swap concept in the insurance industry is the recent emergence of risk exchanges. Catastrophe Risk Exchange (CATEX) New York is a computer-based trading exchange that allows subscribers to swap their catastrophe exposures. Thus, subscribers can adjust their risk distribution profiles -- by geographic location and/or by property type -- by trading written exposures. Risks available for trade can be “advertised” on the electronic system, where trades can be negotiated and completed. In addition, reinsurance can be purchased directly
from reinsurance subscribers.

Another such exchange is CATEX (Bermuda), which is a joint venture with the Bermuda Stock Exchange. This offshore exchange provides a mechanism for the exchanging or purchasing of risks, and is open to insurers, brokers, and capital market investors.

**D. Catastrophe Equity Puts**

Catastrophe equity puts are a form of contingent financing. An agreement is entered into whereby the insurer, in the event of a catastrophe, has the right to sell equity (usually preferred stock) to investors at a pre-specified price. This allows the insurer to shore up its balance sheet by replacing equity after a catastrophe.

**6. Catastrophe Bonds**

Of the various forms of insurance securitization summarized in this paper, the greatest amount of recent activity and publicity has probably involved catastrophe bonds. In this section, the typical catastrophe bond issuance structure is described, and a history and case studies of various offerings are provided. Both unsuccessful and successful catastrophe bond offerings are discussed, with particular attention given to the specific attributes of the largest and most recent offerings, including how catastrophe bond offerings have addressed basis risk and moral hazard through various types of bond triggers. Traits of both “failures” and successful offerings are examined, as are the various “costs” of issuing catastrophe bonds.

**A. The “Trigger” Issue**

An important issue in considering the potential effectiveness of an insurance securitization product is its ability to fulfill its role as a financial risk management hedging instrument. Property/casualty insurance (and reinsurance) itself, for example, can be considered a near-perfect hedge: the intention is to indemnify the insured for the actual loss suffered. Aside from
certain parameters of P/C policies which contractually limit payments -- e.g., policy limits, deductibles, coinsurance provisions -- and assuming that the insured has purchased the “correct” insurance, the only risk of inadequate coverage stems from credit risk: the risk that the insuring (or reinsuring) organization fails and is unable to meet its obligations. Thus, one way to measure the reasonableness of substituting securitized products for catastrophe insurance or reinsurance is to consider the relative effectiveness of the product as a hedging mechanism.

To a large extent, a securitized product’s ability to hedge catastrophe risk depends on the type of “trigger” used. Here, “trigger” is used to refer to the “event” that causes the payoff of the instrument to be adjusted. With respect to this issue, there are two risks:

- **Basis risk**: How closely the company’s losses follow the index used to determine the payoff on the securitized product. In situations where the index is based on aggregate losses to the overall P/C insurance industry, basis risk reflects the difference between the industry’s and the company’s catastrophe loss experience. The concern for a company is that, if its catastrophe experience is worse than the industry’s, the debt relief provided by the bond (which is a function of industry catastrophe experience) will be inadequate to hedge its own losses. Thus, basis risk occurs when a hedge is not exact.

- **Moral hazard**: Increased losses to the company may lead to debt relief -- a decrease in the level of the company’s debt obligations (principal and/or interest). Thus, there may be a perverse incentive for the company to pad its losses in order to take advantage of lower financing expenses.

Basically, there is a trade-off between these two sources of risk. Generally, a situation involving a large level of basis risk will have little or no moral hazard, and vice versa. The relative amount of each type of risk in a given insurance securitization arrangement depends on the specific nature of the trigger -- e.g., direct, industry, or event trigger. A brief description and examples (from Section 6.D and Appendix 1) of each type of trigger follows.
• **Direct**: the contingency upon which the payoff of the instrument depends is based on the company’s losses. Examples include both of the large USAA bond offerings, in which principal and/or interest payments are adjusted in the event of a loss in excess of $1 billion to the company from a category 3 or higher hurricane. With a direct trigger, there is no basis risk, since the payoff on the hedging instrument depends upon the company’s own losses, rather than those of the industry as reflected by an index.

• **Industry**: payoffs depend upon overall industry loss experience, as reflected by an index. Examples include the Swiss Re California earthquake bond, and the CBOT PCS options. With an industry trigger, there is little or no moral hazard (in theory there could be some, since the company’s loss experience may impact the value of the index), but basis risk can be significant. This is because the loss experience underlying the index may not match the loss experience of the company, and so the instrument would provide an imperfect hedge.

• **Event**: payoffs depend upon the occurrence of a defined event. An example is the Tokio Marine & Fire bond which has as its trigger an earthquake that registered 7.1 or more on the Japanese Meteorological Association scale. Potentially, an event trigger can involve significant basis risk, since the “payoff” of the bond is not based on the company’s actual losses, nor even on the industry’s losses, but on the occurrence of an event. (Admittedly, if the bond is constructed properly, the occurrence of the event should logically result in losses to the company.)

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**B. Types of Risk-Taking**

In general, the interest and/or principal payment obligations of an insurer under a catastrophe bond are affected by the occurrence or non-occurrence of a certain level of catastrophic loss. From the investor’s standpoint, depending upon the “tranche” invested in, there is the risk of losing some or all of the principal invested, and/or the risk of diminished or lost interest.
payments. Very often, there is a tranche in which both principal and interest is at risk (and the coupon rate on that tranche reflects this large amount of risk and is, appropriately, relatively high). In addition, there is often a tranche in which at least part of the principal is “protected” or “defeased.” This means that, when the bonds are issued, some of the proceeds are placed in a protected account which funds the repayment of the principal. Often, there is a provision whereby, in the event of a catastrophe, the protected principal is repaid over an extended period of time.

C. Typical Catastrophe Bond Issuance Structure

The issuance structure underlying the catastrophe bonds that have been issued so far has been analogous to that described in Section 3. Typically, an insurance company sets up a Special Purpose Vehicle (SPV) to act as an “intermediary” between the company and the capital markets. Generally, the SPV is an offshore reinsurer; this structure is used to maintain favorable tax and accounting treatments. The SPV issues a reinsurance contract to the company; in turn, the company issues bonds to the capital markets through the SPV. The SPV pays the cash flows on the bonds (and funds the reinsurance protection) from the reinsurance premiums paid by the company, and from the invested bond proceeds.

D. Catastrophe Bond Offerings

The history of catastrophe bond offerings can be segmented into two categories: the “unsuccessful” offerings, and the more recent successes. (One could refine the categorization by adding an intermediate group, which would include the very initial successes that led later to the “bigger” and more widely publicized successes.) The “unsuccessful” offerings include several items in or around 1996, including the first USAA attempt (an offering similar to the one that succeeded just one year later), an offering by ACE (covering U.S. hurricane and earthquake exposures, and having a $25 billion industry trigger), and even the California Earthquake Authority (CEA) (which was going to involve a catastrophe bond, until Warren Buffett’s insurance company provided the coverage at a favorable price using traditional reinsurance).
Each of these offerings “failed” in the sense that they did not result in catastrophe bonds actually being sold to the capital markets. Possible reasons for the failures of these and other products might include:

- Newness and unfamiliarity: A lack of understanding, on the part of the capital markets and/or the insurance industry, regarding the workings of the other side. In addition, sufficient interest in and exposure to the securitization of catastrophe risk had not yet been achieved in the capital markets.
- Uncertainty regarding pricing: There was insufficient time to educate people about the appropriate prices for these instruments. In addition, there was uncertainty regarding the nature and adequacy of modeling and technology with respect to predicting and measuring future catastrophic loss potential.
- Portfolio issues: The potential returns and diversification benefits of investing in such instruments were not yet clear or fully understood.
- Traditional reinsurance: Especially in the case of the CEA, the nature of the underwriting cycle in the mid-1990s made traditional reinsurance pricing seem relatively favorable. (Interestingly, the CEA situation may well have ultimately led to the active securitization market we now see developing. Capital market investors may have reconsidered their cautious attitudes about insurance and catastrophe risks in light of the decision by Warren Buffet -- a respected and influential investor -- to take on such risks.)

In spite of these reasons, and the initial cautious reaction of the capital markets, the first insurance securitization successes appeared shortly thereafter. Among others, some of the early securitization successes included:

- Hanover Re: a reinsurance swap, involving Japanese earthquake and international storm risks.
• Reliance: a placement involving several classes of business, including aviation and property.
• Winterthur: a placement involving the company’s exposure to automobile damage from hailstorms.

These successes set the stage for further offerings, many involving significant size and capital market involvement. Appendix 1 documents the parameters of many of these recent successful securitization offerings -- primarily catastrophe bonds, but a few other items are also included. This listing is approximately chronological. Comments on some of the offerings listed in Appendix 1 follow.

In many ways, the June 1997 USAA bond represented a watershed event in the development of catastrophe bonds. This issue was originally intended to be a $150 million offering, but was significantly over-subscribed. USAA ended up issuing, through a Cayman Islands SPV called Residential Re, $477 million of catastrophe bonds. These one-year bonds were sold to 62 investors; several investment banks were involved in the advising and issuing process. Of the $477 million in proceeds, $400 million represented a reinsurance cover provided by Residential Re; the other $77 million was placed in a defeasance account to fund the principal repayment on tranche A-1. The reinsurance, in effect, represents a layer equal to 80% of $500 million in excess of $1 billion on USAA’s hurricane losses. Thus, the bond involved a “direct” trigger: principal and/or interest payments would be affected in the event of a hurricane loss to the company in excess of $1 billion.

The USAA bond issue involved two tranches: tranche A-1, in which only interest (but not principal) was at risk from the standpoint of the investor; and tranche A-2, in which both principal and interest were at risk. Tranche A-1, which received an investment rating of AAA (the highest), had its principal protected via the aforementioned defeasement account. In the event of a catastrophic loss, principal repayment was guaranteed for tranche A-1 investors, but an extension of as much as ten years to repay the principal would be permitted. Tranche A-2, which
was rated BB (below investment grade), was exposed to the risk of both lost interest and lost principal, and thus was riskier than tranche A-1. This relative riskiness between the two tranches was reflected in their respective coupon rates: the risk premium (coupon rate in excess of LIBOR) for tranche A-2 was more than twice that for tranche A-1.

As discussed later in this section, one of the “costs” of a securitization market in the early stages of its development is the possibility of relatively high yield levels on the securitized products. It is interesting, then, to compare the 1997 USAA bond with the 1998 USAA bond (which was very similar in structure to the 1997 version) in terms of the coupon rates applicable to each tranche. The premiums for each tranche have narrowed significantly, each by well over 100 basis points. Apparently, what has been called the “novelty (or newness) premium” imposed by the capital markets on these bonds has largely worn off. (This decrease in coupon rates may continue as the insurance securitization industry continues to mature -- at least until a catastrophe actually causes a loss for bond investors!)

The July 1997 Swiss Re offering involves an industry trigger: total losses to the insurance industry stemming from a California earthquake. Losses underlying these two-year bonds are measured by a PCS index. Bond losses for Classes A and B are triggered in the event of an earthquake resulting in losses of more than $18.5 billion to the industry ($12 billion for Class C). The proportion of the investors’ capital at risk that is lost in the event of such an earthquake increases as the size of the industry’s loss increases. The offering was in three classes, with partial protection of principal in the first class.

The Tokio Marine & Fire December 1997 offering involves an “event” trigger: bond cash flows are at risk in the event of a Tokyo earthquake registering 7.1 or more on the Japanese Meteorological Association scale. (Actually, slightly different triggers apply depending upon whether the earthquake occurs in an “inner” grid or an “outer” grid.) These are ten-year bonds, issued through a Cayman Islands SPV named Parametric Re.
The Yasuda Fire & Marine offering of June 1998 is interesting from a hazard-level perspective. Investors might well be concerned about the possibility, after bonds are issued, of the company changing its distribution of risk exposures, potentially causing the bonds to increase in risk. This could especially occur under a long-term bond (the Yasuda bonds have a term of at least five years). The Yasuda offering addresses the issue of a change in writings after bond issuance by recalculating the attachment point every year. Significantly, investors agreed to allow the use of a model to reset the attachment point so that there is a constant 0.94% chance of loss to the investors throughout the course of the bond. This indicates that the capital markets are becoming comfortable with the idea of using catastrophe models to estimate event probabilities and prices.

The two swaps at the end of Appendix 1 are also worth mentioning. The X.L. Mid Ocean Re swap is significant for the process involved: a competitive bidding process between traditional reinsurance, capital market instruments (such as catastrophe bonds), and a swap. Perhaps largely due to time constraints imposed by a merger, the offering was done as a swap with the capital markets. Claim recovery is triggered by the level of catastrophe losses incurred by X.L. Mid Ocean Re.

The 1998 Swiss Re arrangement involves as much as $10 million being swapped with a reinsurer. The structure is interesting and unusual: there are two triggers, one applying to industry losses, and the other applying to the reinsurer. Depending upon whether zero, one, or both triggers are exceeded, the swap could result in net payments going from Swiss Re to the reinsurer, from the reinsurer to Swiss Re, in both directions, or in neither direction. While this swap was done with a reinsurer as the “counterparty,” a similar structure might also work with the involvement of the capital markets.

A review of these successful offerings reveals certain traits that are common to many or most of them. These offerings generally involve the following characteristics:
• Highly volatile catastrophic risk
• Relatively high levels of protection
• Relatively short maturities (except, for example, the Japanese issues)
• Some protection of principal is included
• High coupon rates (although the 1998 USAA bond discussed above suggests that the coupon rates have already begun to diminish)

E. Costs of Catastrophe Bonds

There are several costs currently involved in catastrophe bond issuance. The continued development and future success of catastrophe bonds depends largely on the market’s ability to reduce some of these costs. First, offered yields have tended to be rather high. Since the insurance securitization industry is still in its relative infancy, it could well be that default premiums will remain high for a time. As the process further develops and matures, the yields should decline somewhat. The evidence for this is already being seen in the market -- e.g., in the 1997 and 1998 USAA bond coupon rates.

The second set of costs involves setting up the Special Purpose Vehicle. Third are investment banking costs. Typically, investment banks are compensated through advising fees and/or through the spreads between the prices at which they purchase issues, and the prices at which they sell them to the capital markets. Finally, there are legal fees involved in setting up and issuing catastrophe bonds.

7. The Future of Insurance Securitization

The insurance securitization industry has developed quickly. There are a number of issues and questions underlying its potential future development and success.
• Will insurance securitization in general, and property/casualty securitization in particular, survive and grow? Over the last two years, there has been nearly three times as much P/C securitization activity than life insurance activity. Nevertheless, P/C securitization is currently contending with traditional insurance and reinsurance markets that are relatively cheap. The future conditions of the market will have an impact on the development of securitization. In addition, advances in technology will be an important consideration in determining securitization’s future success.

• Will securitization products replace or supplement traditional transactions? So far, the answer has primarily been the latter, despite threats of the former. Nevertheless, the industry does need to adjust to the shift toward the greater importance and influence of capital markets.

• How will securitization affect reinsurance? While it might seem that securitization should represent a threat to the reinsurance industry, it is interesting that many reinsurers have become active securitizers in recent years, setting up securitization departments or subsidiaries. The nature of insurance regulation may also dictate the continued significance of the traditional reinsurance industry.

• Will “capacity” continue to be appealed to as a significant reason for securitization, or will other issues and concerns come to dominate? If the capital markets can promote greater efficiency in the insurance intermediation process, this could be the real value in securitization.

• Will volatile catastrophe risks continue to be the focus of securitization products, or will future instruments contemplate more traditional insurance lines? In many ways, it seems that the latter might provide even greater potential for securitization than the former. Recall that, in general, non-insurance securitization has focused on the high-volume areas such as mortgages and auto loans.

• Are securitization instruments “insurance”? Each jurisdiction will need to come to terms with the question of whether investors in insurance securitization products are engaging in
the business of insurance. In Bermuda, for example, the 1998 Bermuda Insurance Amendment Act said “no”: insurance derivatives are “investment contracts,” not insurance.

- What are the different tax and accounting implications of the various instruments? It should be kept in mind that certain products -- e.g., reinsurance, exchange-traded derivatives -- protect a company’s income statement, while others -- e.g., catastrophe equity puts -- protect the balance sheet. Such differences may affect the relative demands for various products.

- Finally, what form will insurer financial risk management take in the future? There is a wide range of techniques available to insurers – e.g., asset hedges, liability hedges, asset-liability management, contingent financing, and post-loss financing and recapitalization. Insurance securitization encompasses one group of techniques in a broader rainbow of financial risk management tools available for the insurer’s consideration.
Appendix 1

Summary of Recent Successful Securitizations

- **USAA / Residential Re (June 1997)**
  - Size: $477 million, in two tranches
  - Trigger: hurricane losses to company
  - Coverage: 80% of $500 million in excess of $1 billion of losses to the company
  - Tranche A-1: rated AAA
    - $163.8 million, of which $77 million placed in a defeasance account to fund principal repayment
    - Only interest at risk
    - Coupon: LIBOR + 282 bps (basis points)
  - Tranche A-2: rated BB
    - $313.2 million
    - Both principal and interest at risk
    - Coupon: LIBOR + 575 bps

- **Swiss Re (July 1997)**
  - Size: $137 million, in three classes
  - Trigger: losses to industry from California earthquake; PCS index; industry insured loss, from a single event, greater than $18.5 billion triggers losses on first two classes (greater than $12 billion on Class C)
  - 40% of Class A proceeds to defeasance account
  - Coupon rates by class:
    - A-1: LIBOR + 255 bps
    - B: 10.493%
    - C: 12%

- **Tokio / Parametric Re (December 1997)**
  - Size: $100 million, in two tranches
  - Trigger: Tokyo earthquake magnitude; a Japanese Meteorological Association magnitude rating of 7.1 or more involves loss of part or all of principal
  - Half of $20 million proceeds from Tranche A and all of $80 million proceeds from Tranche B are risk capital
  - Ten-year term
  - Coupon rates by tranche:
    - A: LIBOR + 206 bps
    - B: LIBOR + 430 bps
Appendix 1 (cont.)

• Centre / Trinity Re (March 1998)
  - Size: $84 million, in two classes
  - Trigger: FL hurricane losses to company
  - Class A-1 notes ($22 million in proceeds) provide for full principal repayment in event of a loss
  - Includes a trigger reset mechanism in event of a loss
  - Coupon rates by class:
    - A-1: LIBOR + 182 bps
    - A-2: LIBOR + 436 bps

• USAA / Residential Re (June 1998)
  - Size: $450 million, in two tranches
  - Trigger: company losses greater than $1 billion from hurricane
  - Coupon rates by tranche:
    - A-1: LIBOR + 140 bps (compare with 282 bps in 1997)
    - A-2: LIBOR + 400 bps (compare with 575 bps in 1997)

• Yasuda Fire and Marine
  - Size: $80 million offering
  - Trigger: typhoon losses
  - Term: 5-7 years
  - Attachment point recalculated every year with exposure model, so that a constant 0.94% chance of loss to investors is maintained
  - Guaranteed limits and pricing for a second event (reinstatement)

• F&G Re / Mosaic Re
  - Size: $54 million offering
  - Aggregate excess cover for a portfolio of catastrophe reinsurance contracts

• X.L. Mid Ocean Re
  - Size: $200 million offering
  - Coverage: retrocessional hurricane and earthquake
  - Competitive bidding process
  - Swap
Appendix 1 (cont.)

- Swiss Re
  - Basis swap with reinsurer (“ABC”)
  - Up to $10 million transferred
  - Two triggers:
    - SE windstorm losses of ABC
    - SE windstorm losses of industry (from PCS)
    - Exceed trigger?

<table>
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<tr>
<th>ABC</th>
<th>Industry</th>
<th>Result</th>
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<tbody>
<tr>
<td>Y</td>
<td>N</td>
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</tr>
<tr>
<td>N</td>
<td>Y</td>
<td>ABC pays</td>
</tr>
<tr>
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<td>N</td>
<td>Nothing</td>
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<tr>
<td>Y</td>
<td>Y</td>
<td>Pay each other</td>
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</table>
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**SECURITIZATION AND FINANCIAL RISK MANAGEMENT GLOSSARY**

*Act of God bond:* a debt security whose principal and interest payments are contingent upon the occurrence of an event (e.g., a catastrophe, a certain level of catastrophe claims incurred, etc.).

*American option:* an option that can be exercised at any time, up to and including the expiration date.

*Basis:* for a commodity, the difference between the cash (spot) price and the futures price.

*Basis point:* one hundredth of a percentage point. For example, if the yield on a bond falls from 10.0% to 8.5%, it is said that the yield has fallen by 150 basis points.

*Basis risk:* the risk that the derivative security does not move precisely with the underlying “hedged” security; the risk arising from the uncertainty regarding the future basis. For an insurer using catastrophe options as a hedge, it is the risk that the cat option position does not change precisely with the catastrophe experience of the insurer.

*Bermuda option:* an option that can be exercised only on certain dates on or prior to the expiration date.

*Binary option:* an option whose payoff is either zero (if the option is out-of-the-money), or a fixed amount (if the option is in-the-money). Thus, the payoff is discontinuous.

*Bond:* a discounted or interest-bearing security. This security represents long-term debt issued by either a government or a corporation.

*Bond rating:* an evaluation which reflects the probability of default of the issuer of a bond. Ratings are promulgated by organizations such as Moody’s, Fitch IBCA, and Standard & Poor’s. In general, bonds rated BBB or above are considered “investment grade,” while those with lower ratings are referred to as “junk” or “high-yield” bonds.

*Call option:* a derivative security which gives the holder the right to purchase the underlying asset at a pre-specified price (the “exercise” price). A call option is “in the money” and has a positive intrinsic value if the price of the underlying asset is above the exercise price.

*Call option spread* (specifically, a “bullish vertical spread”): a strategy in which a call option with one exercise price is bought, and a call option with a higher exercise price is sold (or “written”). Both options have the same expiration date and the same underlying asset. An example is CBOT catastrophe option spreads, which provide a “reinsurance layer” between the two exercise prices.

*Catastrophe bond:* a bond whose interest and/or principal may be diminished (partially or
completely) in the event of a specified catastrophic event.

**Catastrophe option**: an option based on a catastrophe index.

**Catastrophe Risk Exchange (CATEX)**: a computer-based trading system through which insurers and reinsurers can swap their catastrophe exposures.

**Clearinghouse**: an organization that provides a guarantee that the parties to a transaction will meet their obligations.

**Commercial paper**: unsecured short-term debt obligations, with maturities up to 270 days.

**Debenture**: an unsecured bond.

**Defeasance**: discharging or “funding” of debt through the purchase of new securities. Often, T-bills are purchased and placed in a trust; these bills are then used to meet the obligations from previously issued debt.

**Derivative**: a financial instrument which derives its value from another (“underlying”) security.

**European option**: an option that can be exercised only on its expiration date.

**Financial Engineering**: the use and creation of financial instruments for the purpose of managing financial risks.

**Floating rate note**: a debt instrument with a variable interest rate. The interest rate usually is based on a money market index such as U.S. Treasury bills or LIBOR.

**Forward contract**: agreement to buy or sell a commodity or financial instrument, to be delivered at a future pre-specified date, at a pre-specified price.

**Futures contract**: agreement to buy or sell a commodity or financial instrument, to be delivered at a future pre-specified date, at a pre-specified price. Differs from a forward contract in that it is a standardized contract traded on an exchange, and is marked to market.

**Indenture**: formal bond agreement, or trust deed, between the issuer (borrower) and investors (lenders).

**LIBOR**: the London Interbank Offer Rate. The rate that most international money center banks charge each other for short-term loans. Often used as a benchmark for the rates on certain types of financial instruments.

**Put option**: a derivative security which gives the holder the right to sell the underlying asset at
a pre-specified price (the “exercise” price). A put option is “in the money” and has a positive intrinsic value if the price of the underlying asset is below the exercise price.

**Rule 144a**: An SEC rule dealing with private placements of securities. The rule allows large institutional buyers to buy and sell restricted securities among themselves.

**Secured bond**: a bond backed by specific assets or collateral.

**Securitization**: the process of bundling debt instruments or cash flows into securities which can be traded in the capital markets. This process enhances the credit rating of the instruments and provides additional liquidity.

**Security**: a financial instrument which represents either an ownership interest in, or a creditor relationship with, an asset.

**Surplus note**: fixed-income securities, issued by insurers, which are subordinated to (have lower priority than) policyholder claims. *Contingent* surplus notes are arrangements whereby an insurer has an option to borrow, contingent upon some event (e.g., a catastrophe) or other trigger.

**Swap**: an exchange of one security or set of cash flows for another. Most common with respect to interest rates and foreign currencies.

**Tranches**: classes into which the scheduled cash flows of a security are split. Often, one tranche of an issue has greater exposure to prepayment or default risk than another tranche, and this is reflected in the different rates investors earn on the various tranches.

**Unsecured bond**: a bond not backed by specific assets or collateral, but rather by the integrity of the issuing corporation.
Exhibit 1 -- CBOT PCS Options: Trading Activity

Trading Month

Number

Volume
Open Interest