



## Catastrophe Bonds: An Important New Financial Instrument

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Catastrophe bonds (CAT bonds) are a major category in the class of securities known as insurance-linked securities or ILS. Their purpose is to crowd-source reinsurance coverage, in order to reduce reinsurers', insurers', and self-insurers' reserve requirements and reduce their cost of coverage. At the same time they are attractive to investors, because the risks they cover are virtually uncorrelated with other risks such as equity market risk, interest rate risk, and credit risk.

The investor purchases the bond with a principal payment then receives regular periodic payments, usually quarterly. The bond has a maturity which ranges from one year to five years but is typically three years. If a covered catastrophe exceeding the "trigger" point defined in the bond's contract occurs during the period before maturity, then the bond defaults and a portion or all of the principal paid for the bond by the investor may not be returned, going to cover the issuer's indemnities. The issuer is usually a reinsurer,

but may be an insurer, a government entity, a corporation, a pension fund, or even a nonprofit organization. Catastrophes typically covered include damages from extreme earthquakes and high winds but can also include high or low extremes of mortality and other risks.

The investor's principal payment is invested in safe securities, such as a U.S. Treasury money market fund, thus minimizing or eliminating credit risk. The payments to the investor consist of the interest on those investments plus the premiums paid by the cedent – the issuer of the bond. Loss of principal is triggered by the occurrence of the covered catastrophe. The specific trigger and the amount of principal lost depend on the trigger type, which can be an indemnity trigger, industry trigger, parametric trigger, or modeled trigger. An indemnity trigger is tripped by claims on the cedent in the event of a catastrophe exceeding a specified amount. An industry trigger is tripped by claims on the entire insurance industry for the specified event in a region. A parametric trigger

is tripped by a specified quantitative severity of the catastrophe, while a modeled trigger is tripped by modeled claims greater than a specified amount.

The market for CAT bonds has developed rapidly since their introduction about 20 years ago. Outstanding issues stood at \$20 billion at year-end 2013. Issuance has increased rapidly, with \$5.7 billion in new issues in the first half of 2014 alone. Recent CAT bond spreads have been about 2-3% higher than those of comparably-rated high-yield corporate bonds, and rates of return have averaged in the range of 7-9% annually since 2002 with little volatility.

### Overview of CAT Bonds

“Reinsurance” is insurance purchased by insurance companies to cover so-called “tail risks”, that is, risks so severe that the insurance companies themselves would not have enough reserves to cover them. For example an insurance company that has sufficient reserves to pay claims of up to \$1 billion but no more, in the event of a catastrophe such as a hurricane or an earthquake, may purchase reinsurance from a reinsurance company to cover claims in excess of \$1 billion. In turn, a reinsurance company may purchase reinsurance of its own tail risks from yet another or several other reinsurance companies. This purchase of reinsurance by reinsurers is called retrocession. Each reinsurer must have sufficient reserves to cover the claims that it may be called upon to cover with a high level of probability.

Catastrophe bonds, or CAT bonds, were created in the mid-1990s after Hurricane Andrew, the most costly hurricane in U.S. history, caused sufficient damage to bankrupt some insurance companies. This led insurers and reinsurers to seek new ways to ensure that they had adequate capital to cover claims in the event of future disasters.

Recently China Daily (2013) reported that China’s National Development and Reform Commission, in a strategy guideline, encouraged the issuance of CAT bonds as a way to leverage financial resources in response to climate change.

### The Mechanics of CAT Bonds

At this time CAT bonds are issued and trade mainly in the institutional investor marketplace, in which, in the U.S., securities sales are exempt from most regulatory reporting requirements under Rule 144A of the Securities Act of 1933, if sold in transactions of at least \$150 million each to institutional investors. These institutional investors may be dedicated CAT bond funds, which operate like hedge funds, and in which institutional funds such as pension funds and endowment funds as well as accredited (wealthy) individual investors may invest, or they may be those institutional funds directly, or in a few cases, other pooled funds such as mutual funds and hedge funds.

From the standpoint of cash flows, to an investor a CAT bond looks similar to a corporate bond. The investor purchases the bond with a principal payment approximately equal to the face value of the bond then receives regular periodic payments, usually quarterly. The bond has a maturity which ranges from one year to five years but is typically three years. If a covered catastrophe exceeding the “trigger” point defined in the bond’s contract occurs during the period before maturity, then the bond defaults and a portion or all of the principal paid for the bond by the investor

may not be returned, going to cover the issuer’s indemnities. The issuer is usually a reinsurer, but may be an insurer, a government entity, a corporation, a pension fund, or even a nonprofit organization.

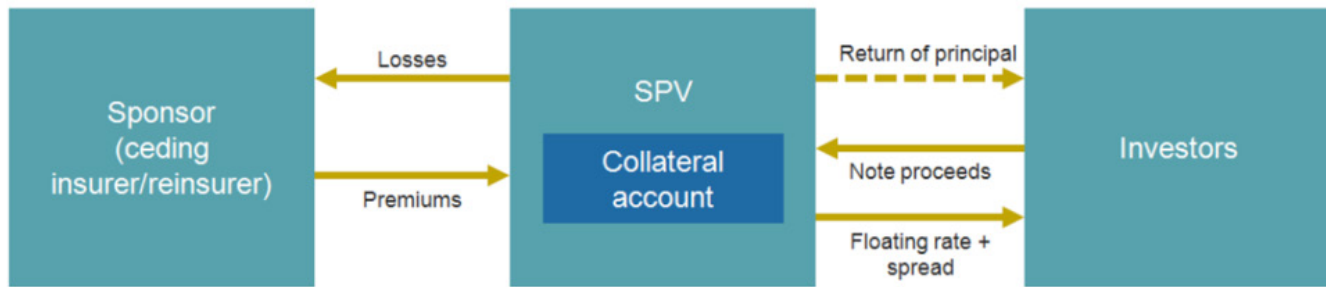
The principal paid for the bond is deposited in very safe securities, usually a U.S. Treasury money market fund, to ensure that the funds are kept in reserve to cover claims in the event that the covered catastrophe occurs. This practice of investing the funds in very safe securities supersedes a practice that was prevalent in the mid-2000s. At that time in order to offer investors a floating rate of LIBOR (the London Interbank Offer Rate) plus a fixed premium, issuers would enter into an interest rate swap with an investment bank counterparty. However, four CAT bonds defaulted in 2008 when one of those counterparties, Lehman Brothers, went into bankruptcy and could not honor its side of the interest rate swap. Those four defaulting CAT bonds represent one-third of all CAT bonds that have defaulted so far, the other eight having defaulted due to the occurrence of natural catastrophes.

Typically the issuer of a CAT bond uses it to cover a “slice” of risk, for example indemnities exceeding \$1 billion but not to exceed \$1.2 billion. In this case the amount of the bond would be \$200 million. The \$1 billion is called the “attachment point”, at which at least a portion of principal must be attached to cover claims. The \$1.2 billion mark is called the “exhaustion point”, at which principal is exhausted and investors are not liable for any further claims.

The attraction of CAT bonds to investors is two-fold. First and most important, because it is the reason why the CAT bond market is likely to remain very attractive to investors for a long time and to grow steadily and rapidly, is that the risk of CAT bonds is virtually uncorrelated with the other risks that investors assume, namely the risk of equity market fluctuations, credit risk, and interest rate risk. The occurrence of natural catastrophes is in general uncorrelated with events in the broad economy such as stock market and interest rate movements and inflation. And since the abandonment of the interest rate swap contract that failed when Lehman Brothers failed, investors’ principal is deposited in the safest securities available.

The second attraction to investors is that CAT bonds have been offering high rates of interest consisting of the base interest on the Treasury money market funds in which they are deposited, which currently offer only a low interest rate, plus the premium paid by the issuer for their insurance coverage feature. This interest rate has so far been high compared to the risk of default.

For the issuer the attractions of CAT bonds are that it reduces the issuer’s reserve requirement, increases its insurance protection, and poses no or negligible credit risk. In addition issuers can tranche CAT bonds, for example by issuing one \$200 million CAT bond to cover the slice of risk from \$1 billion to \$1.2 billion and another \$200 million CAT bond to cover the slice from \$1.2 billion to \$1.4 billion. The tranche with the higher attachment point, \$1.2 billion, will of course be of higher quality (lower default probability) than the tranche with the lower attachment point, \$1.0 billion.



### Exhibit 1: CAT bond structure;

Source: Risk Management Solutions, Inc. (2012)

Exhibit 1 shows the structure of a CAT bond transaction. The special purpose vehicle (SPV) is necessary because otherwise investors would be directly offering insurance to the issuer, which they could not do without receiving regulatory authority – a license – to assume risk under a contract of insurance. The SPV is therefore also sometimes called a “transformer” because by being licensed itself to sell insurance, it transforms the investment of funds by the investors into a sale of insurance. When domiciled in an offshore location such as Bermuda or the Cayman Islands, it also provides ease of licensing and simplified and often lowered tax requirements.

### Trigger Types

The most complicated aspect of the creation of a CAT bond is defining what triggers loss of principal. Four basic trigger types are possible:

- Indemnity trigger: covers actual excess claims paid by issuer
- Industry loss trigger: coverage based on whole-industry losses on the extreme event
- Parametric trigger: coverage based on exceedance of specified natural parameters
- Modeled trigger: coverage based on claims estimated by a computer model

### Indemnity trigger

The attachment point of an indemnity trigger is defined by the actual claims or losses of the CAT bond’s issuer. Hence, if the attachment point is \$1 billion that means that loss of principal will trigger when the claims that must be paid to claimants by the issuer total in excess of \$1 billion in aggregate. If the exhaustion point is \$1.2 billion (and thus, the bond issue is for \$200 million) then principal will be exhausted when claims actually paid to claimants equal or exceed \$1.2 billion.

The indemnity trigger is the most advantageous for the issuer because it leaves the issuer with no “basis risk”, which is the difference between what reinsurance pays the issuer and what the issuer will have to pay to claimants. However, the indemnity trigger is least attractive to the investor because it poses the likelihood that the investor will have to wait a long time after the occurrence of a triggering event, and possibly a long extension period after maturity of the bond, to reclaim a portion of principal – if any – because repayment must wait for all claims to be settled. Furthermore because the issuer retains no basis risk, it poses the

danger of moral hazard – the issuer will have little incentive not to underwrite excessive risks, for example homes constructed in high hurricane-risk zones.

### Industry loss trigger

An industry loss trigger is based on index estimates of total industry losses on the insured event created, after the event has occurred, by an independent third party service, such as PCS (Property Claims Service) in the U.S. and PERILS in Europe. If a triggering event occurs, such as total industry losses in excess of, for example, \$10 billion, then the investors are liable for the percentage of the industry represented by the CAT bond’s issuer’s share. This subjects the issuer to basis risk because the claims that the issuer must pay may not be exactly equal to its share of the industry loss, and the estimate made by the independent third party service of total industry losses may not be exactly equal to the actual total industry losses. However, this is more advantageous than a pure indemnity trigger for the investor because the claims are settled more quickly, once the independent third party service estimates industry losses (by surveying the participants in the industry for their estimates), and because moral hazard is lessened since the issuer assumes some basis risk.

### Parametric trigger

A parametric trigger is based on the occurrence of a specific natural event, such as wind speed exceeding 120 km/hr (in a specified location), or hurricane category 5, or an earthquake exceeding 7.0 on the Richter scale. While this poses basis risk to the issuer, it is advantageous to the investor because little or no waiting time is required before settlement of the bond after a triggering event, resolution of losses is rapid and transparent, and the danger of moral hazard is low.

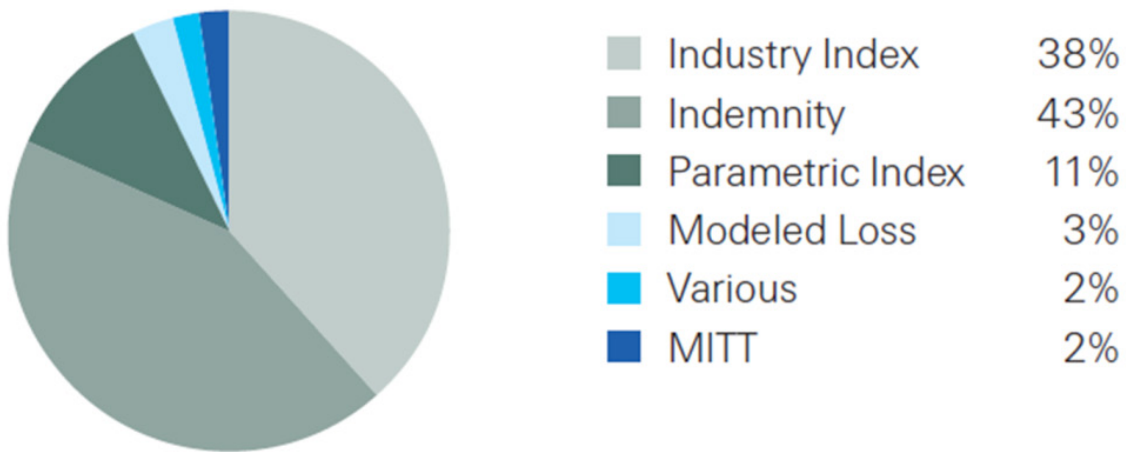
### Modeled trigger

A modeled trigger is like an indemnity trigger, but instead of being based on actual claims it is based on claims estimated or projected by an independent modeling company. Hence, loss resolution after a triggering event can be more rapid than with a pure indemnity trigger, and the issuer retains some basis risk.

### Trigger breakdown

Exhibit 2 shows the distribution of trigger types of outstanding CAT bonds as of December 31, 2013. It can be seen that most CAT bonds issued have either an indemnity trigger or an industry loss trigger. (MITT and “Various” are hybrids of the triggers.)

# Sector Data as of 31 December 2013



## Exhibit 2: Trigger breakdown

Source: Swiss Re Capital Markets (2014)

### Market Overview and Participants

The participants in the CAT bond market include issuers, structuring agents, modeling agents, ratings agencies, performance index compilers, investors, industry loss index compilers, and media. The following provides more details about these participants.

#### Issuers

Issuers are typically reinsurers and insurers such as Munich Re, Swiss Re, USAA, AIG, Aetna, Chubb, and Berkshire Hathaway, but can also be a government entity, corporation (e.g., electric utility), or a pension fund seeking to cover an unanticipated lengthening of longevities.

#### Structuring agents

Structuring agents assist the issuer in selecting the trigger type and the level of protection, that is, the attachment and exhaustion points. These are determined by what the structuring agent believes can most advantageously be sold to investors. The structuring agent also assists in placing the bond with investors. Structuring agents are usually investment banks or the capital markets arm of a major broker or insurer. Examples include Swiss Re Capital Markets, Deutsche Bank Securities, Goldman Sachs, Aon Benfield Securities, and Towers Watson Capital Markets.

#### Modeling agents

Modeling agents estimate the risk of the catastrophe bond. For example their models may estimate that the probability of reaching the attachment point \$1 billion in a CAT bond is 1.5%, and the probability of reaching the exhaustion point \$1.2 billion is 0.5%. They also model the loss in case of a modeled or industry loss trigger. The models are based on simulations of the many possible scenarios in which a catastrophe could unfold – for

example paths of a hurricane or locations of the epicenter of an earthquake – and then estimating the monetary value of the damage that would take place for each scenario. There are three main modeling agents, Risk Management Solutions, Inc. (RMS), AIR Worldwide, and Eqecat.

#### Ratings agencies

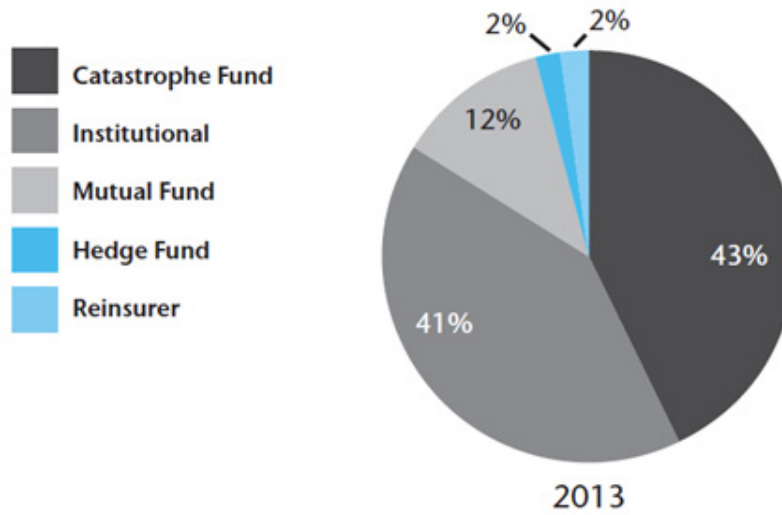
Both Standard & Poors (S&P) and A. M. Best rate CAT bonds. S&P typically rates them at below investment grade, either BB or B rating, similar to high-yield (“junk”) bonds, due to their high probability of default (historically averaging 1.4%).

#### Performance index compilers

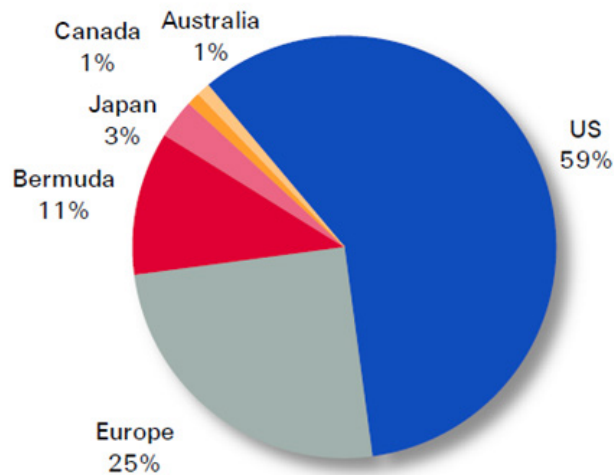
The appearance of a secondary market in CAT bonds (see below) has facilitated the regular computation of average CAT bond prices and thus the calculation of performance indices, i.e., rates of return on investment over historical time periods. These computations are performed regularly by Swiss Re and Aon Benfield to present their Swiss Re Global CAT Bond Index and Aon Benfield ILS Indices, respectively.

#### Investors

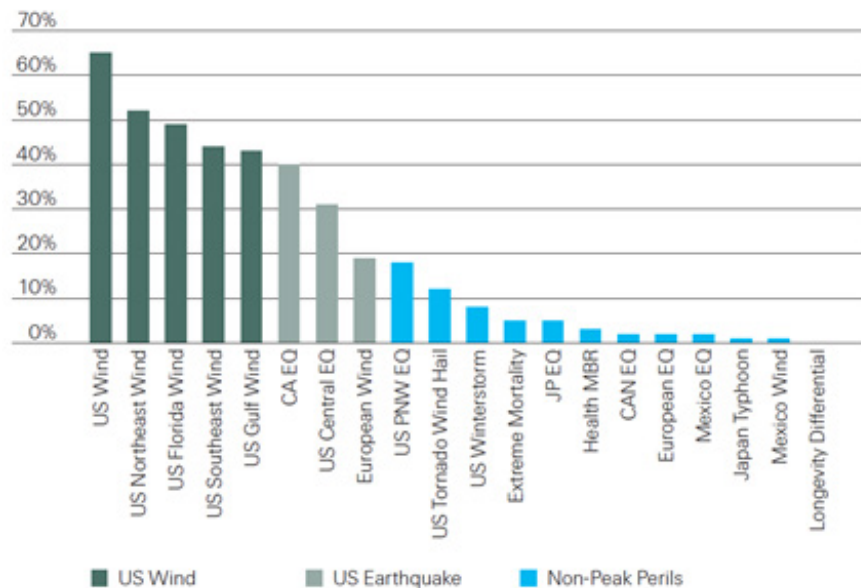
The ultimate investors in CAT bonds are principally institutional investors such as pension funds, endowment funds and hedge funds. Primary investors are both institutional investors investing directly and dedicated ILS funds such as those managed by U.S.-based Fermat Capital Management, Inc., and Swiss-based Plenum Investments Ltd., which are organized like hedge funds and in which institutional investors and accredited individual investors can invest. Institutional investors that invest directly include such entities as TIAA-CREF, the academic and nonprofit organization retirement fund manager, Ontario Teachers fund, and hedge funds like DE Shaw and AQR.



**Exhibit 3: CAT bond investors by category**  
Source: Aon Benfield (2013)



**Exhibit 4: CAT bond investors by region**  
Source: Swiss Re Capital Markets (2014)



**Exhibit 5: CAT bond by peril**  
Source: Swiss Re Capital Markets (2014)

Exhibit 3 shows the breakdown of CAT bond investors by category, Exhibit 4 shows the breakdown of investors by region, and Exhibit 5 shows the breakdown of CAT bonds by peril (figures add up to more than 100% because some CAT bonds cover more than one peril in a single bond).

#### *Industry loss index compilers*

The main compilers of industry loss estimates are Property Claims Services (PCS) in the U.S. and PERILS in Europe. Estimates are made through confidential surveys of “insurers, agents, adjusters, public officials, and others” to gather data on claims volumes and amounts, which are then combined with trend factors to determine a loss estimate (PCS, 2014). PERILS industry index values are generally made available six weeks after a triggering event, with updates after three, six, and twelve months (PERILS, 2014).

#### *Media*

The Bermuda-based online web site ARTEMIS ([www.artemis.bm](http://www.artemis.bm)) provides extensive news coverage of CAT bonds, insurance-linked securities, and reinsurance capital and investment.

#### **The CAT Bond Market, Returns, Spreads, and Ways to Invest**

CAT bond offerings are customarily structured as private placements. The placement agent / (structuring agent) contacts a limited number of prospective investors to place them. No CAT bonds are publicly offered or traded in the U.S. A secondary market exists in which CAT bonds are transferred among qualified institutional buyers, facilitated by a market maker, based in the U.S. on the Rule 144A exemption. Secondary market transactions are about equal in volume to primary market transactions. Demand at year end 2013 exceeded supply (some issues traded in the secondary market immediately after issue at 1-2% premiums); thus, of the 10.8% 2013 Swiss Re Cat Bond Global Index return the price component returned 2.2% while the coupon component returned 8.5%.

Issuance of CAT bonds peaked at over \$7 billion in 2007 but declined after the defaults caused by interest rate swaps that were not honored after the Lehman bankruptcy. Since 2009 however, issuance of CAT bonds has increased rapidly, reaching USD7.42 billion in 2013 in 31 transactions. At year-end 2013 there were USD20 billion in CAT bonds outstanding. In the first half of 2014 18 CAT bonds were issued totaling \$5.7 billion, with \$4.5 billion of that in the second quarter. (Property Claims Services, 2014b; Swiss Re, 2014; artemis.bm, 22 January 2014 and 19 February 2014.) CAT bond default rates have been low, with defaults approximately in line with or below model estimates. Defaults have totaled about 1.4% of principal on average. There have been twelve defaults in total, four of them due to the Lehman bankruptcy and its consequent interest rate swap defaults. Three CAT bonds defaulted in 2011 – two due to tornados in the U.S. Midwest and one due to the 2011 Tōhoku earthquake and tsunami in Japan – and none defaulted in 2012 and 2013. (Plenum, 2011, 2012, 2013.) CAT bond spreads (interest rates in excess of U.S. Treasury rates) are about 2-3% higher than those of comparably-rated high-yield corporate bonds (Swiss Re, 2014). Rates of return have averaged in the range of 7-9% annually since 2002 with little volatility.

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Michael Edesess, a mathematician and economist, is a senior research fellow in the Centre for Systems Informatics Engineering at City University of Hong Kong, a principal and chief strategist of Compendium Finance, and a research associate at EDHEC-Risk Institute. In 2007, he authored a book about the investment services industry titled *The Big Investment Lie*, published by Berrett-Koehler. His new book, *The Three Simple Rules of Investing*, coauthored with Kwok L. Tsui, Carol Fabbri, and George Peacock, was published in June 2014 by Berrett-Koehler. He writes regularly for the online publication *Advisor Perspectives*.