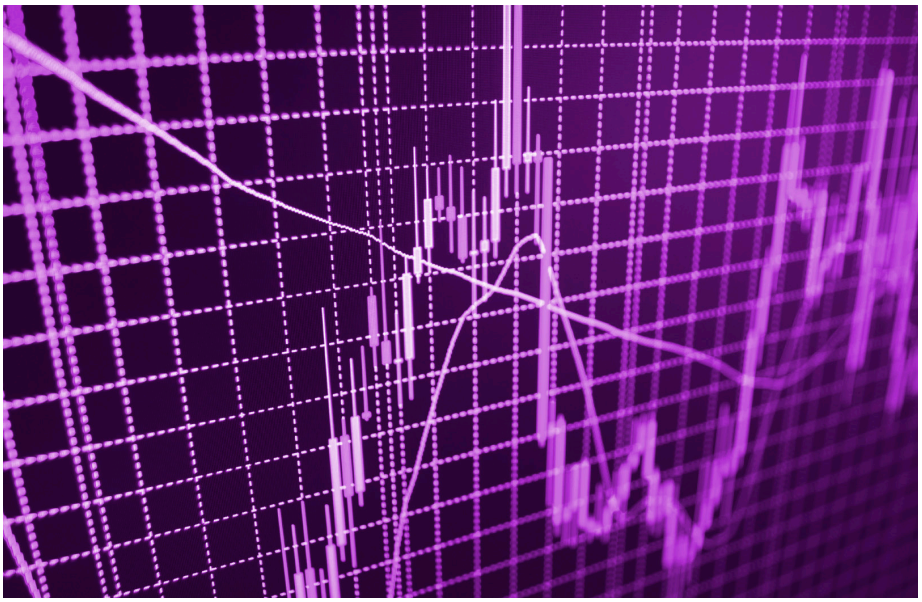
PartnerReviews

The Drivers of Catastrophe Bond Pricing

Catastrophe bonds provide a means for investors to achieve returns that are uncorrelated with the broader financial markets. Niraj Patel, ILS Portfolio Manager, PartnerRe, explains how portfolio managers can make more informed decisions around capital allocation by understanding the attributes of pricing trends. In this paper he provides a comprehensive analysis of catastrophe bond pricing over the last 15 years to determine the specific factors and conditions that drive pricing.



Yield to maturity and credit spread

Yield to maturity of a bond is the total yield resulting from all coupon payments and any gains/losses from appreciation/depreciation in the price of the bond an investor achieves upon holding the bond to maturity. This appreciation/depreciation is a result of purchasing a bond at a discount/premium to face value.

The yield of a bond can be broken down into two components: risk-free interest rate (government bond yield) and credit spread. The difference between the yield on a bond and the yield on a matched maturity government bond is called the credit spread.

Credit spread of a corporate bond is affected by the default risk (expected loss of principal) and the risk premium demanded by investors for taking on this risk. Highly leveraged companies are riskier, implying higher probability of default and therefore, provide higher credit spreads. Thus, lower-rated or below investment-grade corporate bonds (high-yield corporate bonds) provide higher spreads than high-quality investment-grade corporate bonds.

Over the last few years, insurance companies have made increasing use of catastrophe bonds[1] to transfer insurance risk to capital markets. The first successful catastrophe bond was an $85mm issue by Hannover Re in 1994. This was followed by Swiss Re in 1995, Georgetown Re in 1996 and financial services company, USAA's first Residential Re catastrophe bond in 1997. These early transactions provided investors with an opportunity to assume catastrophe risk on a securitized basis for the first time. Since then, catastrophe bonds have evolved into valuable risk management and investment tools by incorporating elements from both the reinsurance and debt capital markets.

From a ceding company's perspective, catastrophe bonds operate as a substitute for property catastrophe reinsurance. More specifically, they provide an alternative means to capitalize a reinsurance transaction. The ceding company purchases reinsurance from a Special Purpose Vehicle (SPV), formed for the sole purpose of entering into a specific transaction; paying the SPV a premium as consideration for the exposure it is ceding. The SPV uses this premium to pay interest to the bond holders providing capital. The capital is invested in high quality collateral and is available should there be losses associated with the reinsurance transaction.

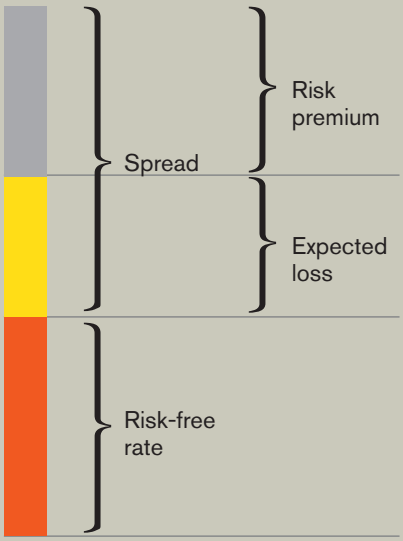
Understanding pricing to understand return

From an investor's perspective, the main attraction of catastrophe bonds is the fact that they provide relatively higher yields on a diversifying asset class. Unlike traditional reinsurance, catastrophe bonds can be traded on a secondary market, introducing characteristics generally associated with fixed income securities, such as duration, discount margin and yield to maturity.

[1] For background on catastrophe bonds, reader can refer to a number of available primers. One such primer can be accessed at www.air-worldwide.com/Publications/AIR-Currents/So-You-Want-to-Issue-a-Cat-Bond/

In addition to the company specific or idiosyncratic factors, overall economic and business cycles tend to affect credit spreads. A slowing economy tends to widen credit spreads as companies are more likely to default, and a growing economy tends to narrow the spread, as companies are theoretically less likely to default. Finally, risk premium or margin demanded by investors also changes over time and is affected by, among other things, cross-asset relative value considerations and changing perception of risks. The higher the uncertainty associated with risky assets, the higher the risk premium demanded by investors. Note that different market participants may have forward looking views of the expected loss that often differ from each other and from statistically derived historical estimates.

Breakdown of bond yield



Not to scale.
For simplicity, any optionality embedded in the bond (for example a call feature) is not considered here.

Catastrophe bond spread

Catastrophe bonds are issued as floating rate securities, in which the investor receives a set coupon spread over an index (or return on high-quality collateral, which is typically invested in short-term money market funds). The index (or collateral return) is intended to compensate investors for holding their money and is not affected by riskiness of the bond (i.e. embedded insurance risk). It resets periodically based on the prevailing short-term interest rates. The spread of a catastrophe bond is intended to compensate investors for the insurance risk.

Discount margin of a floating-rate bond

Discount margin of a floating-rate bond is the return earned over and above the index underlying the bond. If the bond's price is equal to par (or face value), its discount margin is equal to the coupon spread over index. If the price of the bond is less than par, the discount margin is greater than its coupon spread. This is because of the tendency of the bond price to converge to par as the bond reaches maturity. Thus, an investor can make additional return over the coupon spread for a bond priced at a discount. Conversely, for a premium bond, discount margin is less than the coupon spread.

Duration and interest-rate sensitivity

Duration is a measure of the sensitivity of the price of a bond to change in interest rates.

Since catastrophe bonds are floating-rate securities in which the index (or collateral return) resets periodically to prevailing short-term interest rates, the interest-rate sensitivity of catastrophe bonds is rather low. Corporate bonds, on the other hand, are often fixed-rate bonds, in which the coupon yield is fixed at issuance. Thus, as interest rates change, corporate bond prices change even if nothing else changes. That is, the interest-rate sensitivity of corporate bonds is higher.

The payment a buyer of reinsurance must make – otherwise known as the "premium" in insurance, or the "coupon" in bond markets – is generally fixed; however, the spread achieved by an investor depends on the price of a bond, as well as its coupon payment stream. Specifically, the spread achieved by investors is inversely related to the price of the bond.

Drivers of catastrophe bond spread

Similar to other risky bonds, catastrophe bond spread is a function of modeled expected loss and risk premium. Modeled expected loss, also known as loss cost or average annual loss, is the average value of losses over a full range of scenarios[2]. The risk premium is the required margin. These two factors drive the spread of a catastrophe bond. Thus, catastrophe bond spread is similar to premium or rate on line in the traditional reinsurance market.

The risk premium or margin is not constant; rather it is a function of peril zone and modeled expected loss. Moreover, changing perceptions of risk and relative value considerations mean that risk premium changes over time. Note that true underlying value of expected loss is not known; rather modeled expected loss values are just estimates of the true expected loss. This uncertainty in estimating expected loss manifests itself in margin being a function of the expected loss itself. Peak peril zones (e.g. Florida hurricane) typically demand higher margins due to concentrations in investors' ILS portfolios compared to diversifying peril zones (e.g. Turkish earthquake). Moreover, given comparable loss costs, the market charges a higher margin for complicated, or less homogeneous risks, such as commercial properties vs. personal lines. Again, this is due to higher uncertainty in estimating expected loss for complex risk, which results in the market demanding higher margin.

The risk premium (and therefore, spread) is also influenced by trends across

[2]Catastrophe bonds provide excess of loss (or aggregate excess of loss) reinsurance cover and are similar to securitized products, such as asset-backed securities or mortgage-backed securities. A catastrophe bond suffers a loss only if a qualifying event results in losses in the subject business that exceed a certain threshold (attachment point). If the subject business losses are high enough to reach the exhaustion point, a catastrophe bond loses100% of the principal. Expected loss referenced here is based on losses suffered by catastrophe bonds after taking into account the attachment and exhaustion points, rather than the ground up subject business losses.

years, so called soft and hard markets. In a soft market, the cost of coverage drops, while in a hard market it rises. Historically, hard markets have followed years with significant loss activity resulting in depletion of reinsurance capital. Sometimes this increase is localized to a specific area impacted by loss, while at other times it can raise the cost of reinsurance across the entire market.

The spread can also shift due to a change in perception of expected loss. For example, during a very active hurricane season or when a hurricane is approaching the U.S. coastline, the market perceives a higher probability of loss. In these types of scenarios, the spread widens due to increase in expected loss.

Finally, in recent years, broader market trends have had a significant influence on the price of risk (risk premium) and consequently catastrophe bond spreads. As we will show, spreads can also widen during periods of extreme economic turmoil, unrelated to natural catastrophes.

Catastrophe bond spread performance since 2001

We now examine historical spread performance of catastrophe bonds to illustrate its drivers. **Exhibit 1** (below) shows

"Live cat" trading

A hypothetical example to illustrate changing perception of risks is the behavior of a Florida hurricane bond as a category five storm approaches Miami. In this scenario, if the storm looks as though it will maintain its track and strength, the probability of loss – triggering a payout on the bond – would rise. This would result in a drop in the price of the bond and an increase in the spread. If conditions change – either diverting the storm into open water or losing strength – and thereby averting a loss, the price would rebound and the spread would decrease again. Trading of catastrophe bonds as a potential event is unfolding (e.g. a storm is approaching U.S. coastline) is often referred to as "live cat" trading and is only possible because there is a secondary market for these bonds.

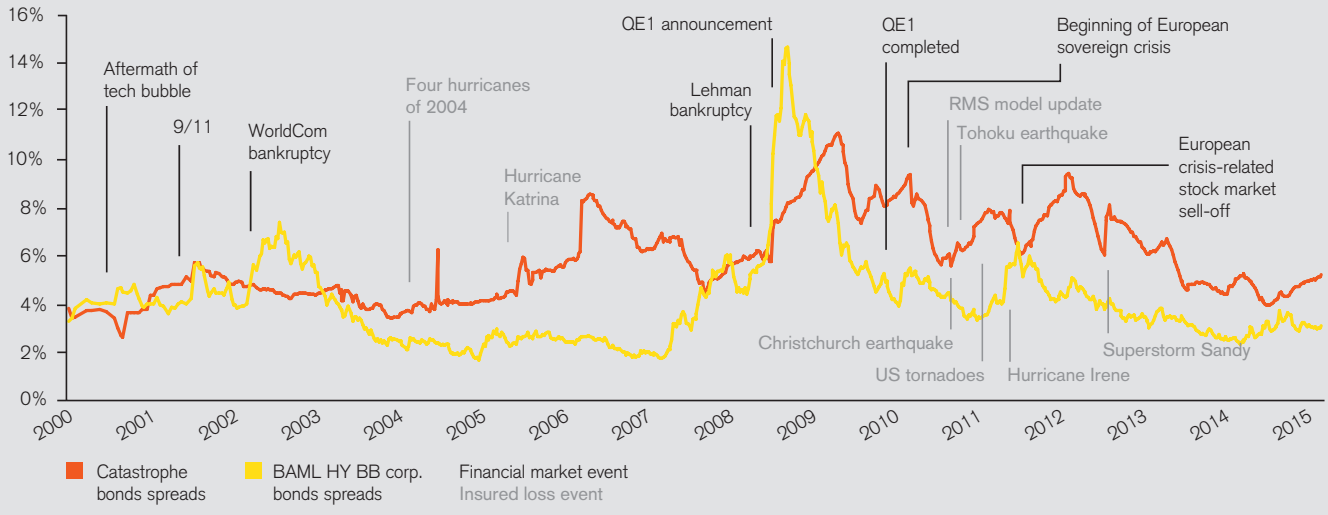


Exhibit 1: Catastrophe bond and high-yield corporate bond spreads

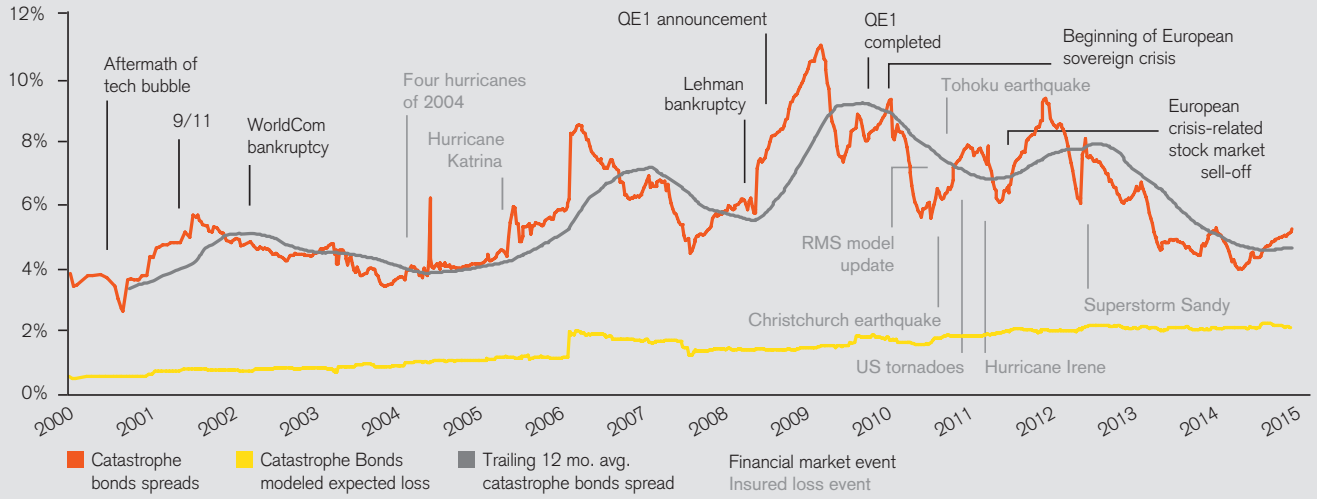


Exhibit 2: Catastrophe bond spreads and modeled expected loss

catastrophe bond and high-yield corporate bond spreads. **Exhibit 2** (above) shows catastrophe bond spreads along with rolling twelve-month average spreads. The modeled expected loss is also included in this chart. **Exhibit 3** (below) shows the property catastrophe rate on line (ROL) index.

Over the last 15 years, there have been four episodes of significant spread widening across the entire catastrophe bond market. This is easier to see in Exhibit 2, which smooths out short-term volatility by plotting rolling 12-month average spreads. Note that this averaging introduces approximately six months of lag in the timing of spread movements. These trends are examined in greater detail on the following page.

2001–2002: The first observable incidence of spread widening occurred just as the 21st century began. There were two notable events at the turn of the century that had an impact on the price of risk or risk premium: the implosion of the technology bubble and the September 11th terrorist attacks. The latter put a strain on the reinsurance market that had already sustained large casualty losses in the late 1990s and two sizable European catastrophes in December 1999 (Windstorms Lothar & Martin). While rates went up in the reinsurance market, and spreads widened in both catastrophe and high-yield corporate bond markets, the rise was most pronounced in reinsurance and catastrophe bonds.

After an initial spike, catastrophe bond spreads and reinsurance rates started a long decline through the third quarter of 2005. During this period, high-yield corporate bonds experienced another period of spread widening during 2002–2003 but the downward trend in reinsurance rates and catastrophe bond spreads did not subside. Not even the active 2004 hurricane season altered the course, because it did not impact the amount of reinsurance capital available.

Throughout this period, apart from a small impact from broader economic conditions, the driver of spreads remained the reinsurance cycle and the availability of reinsurance capacity.

2005–2006: Hurricane Katrina in August 2005 was the costliest catastrophe in reinsurance history, and it had an immediate impact on the supply of reinsurance capital at the precise time that demand increased, causing an imbalance in the reinsurance market. Post-Katrina models were recalibrated to include increased assumptions for severity and frequency of hurricanes and enhancement in loss modeling. Perception of risk and modeled expected loss increased. Moreover re/insurers' capital requirement for a given rating increased. Catastrophe bond spreads widened along with reinsurance rates. The first major catastrophe bond default, Kamp Re, reinforced the trend. During this period

Exhibit 3: Guy Carpenter Property Catastrophe Rate on Line Index

of turmoil in the re/insurance market, the economy was experiencing a housing-driven boom and high-yield corporate bond spreads remained stable.

This period demonstrated a clear distinction between the market for reinsurance and the broader economy, thereby highlighting the uncorrelated nature of catastrophe bonds.

2008–2009: The housing market bust and financial crisis altered this relationship for the first time. The financial market stress was so great that it caused a liquidity crunch across all markets as investors liquidated any assets they could to meet financing and margin call requirements. This led to significant repricing of risk (increase in risk premium) across all asset classes, even those like catastrophe bonds that were not directly impacted by the crisis. Both catastrophe and high-yield corporate bonds spreads widened significantly. The rise in catastrophe bond spreads occurred with a slight time delay and the increase was not as pronounced. In general the catastrophe bond market demonstrated a remarkable liquidity and relative price stability (compared to other asset classes). This may have been due to the fact that a significant portion of catastrophe bonds was held by "ILS only" funds which did not face the level of liquidity calls other funds endured.

Traditional reinsurance rates increased slightly in 2009, but not to the same extent as widening of catastrophe bond spreads. Towards the end of 2009 and beginning of 2010, as the crisis was coming to an end, spreads for both catastrophe and high-yield corporate bonds began to tighten. Reinsurance rates also declined.

This period showed the first evidence that the market for catastrophe bonds was not as decoupled from the broader financial market as previously perceived. The fact that it took a financial event of the scale of the Great Recession (generally considered to be the largest economic downturn since the Great Depression) to trigger this correlation, simply highlights the excellent diversification catastrophe bonds can provide in a portfolio.

2011–2012: 2011 was another year of substantial catastrophe losses globally. The industry suffered losses due to the New Zealand Christchurch earthquake, the Japan Tohoku earthquake and tsunami, flooding in Thailand and record-breaking severe convective storm losses in the U.S. Three catastrophe bonds (Muteki, Mariah Re 2010–1 and Mariah Re 2010–2) suffered losses of principal.

RMS released an update to their U.S. hurricane model in 2011 which produced a significant increase in modeled expected losses. This led to a perception of higher risk and caused spreads to widen in the catastrophe bond market.

Financial events, such as European sovereign crises caused a widening of high yield corporate bond spreads as well, but the events within the re/insurance industry described above were the primary drivers of widening of catastrophe bond spreads.

Since 2012, catastrophe bond spreads have continued to tighten, consistent with the drop in reinsurance rates. This trend has been driven by an influx of alternative capital and increase in traditional reinsurance capital.

Large losses and financial market shocks will continue to impact returns

Based on historical experiences, one can draw the following conclusions:

Conditions in the reinsurance industry have a direct impact on catastrophe bond spreads. Large insured losses have historically led to a reduction in available capital and therefore an increase in risk premium demanded by investors/counterparties. Change in perception of risk due to unexpected losses has also led to widening of spreads.

Broader financial market events, if severe enough, can also have an impact on spreads. An increase in the risk and liquidity premium demanded by investors causes insurance-linked securities' spreads to widen based on relative value considerations. This linkage with broader financial markets is not surprising and may increase in importance as the role of alternative capital in re/insurance grows.

This has important implications for the future of reinsurance and catastrophe bond pricing for both ceding companies and investors. For ceding companies,

Impact of Lehman Brother's bankruptcy on catastrophe bonds

While catastrophe bonds were not triggered by any insurance events during the financial crisis in 2008–2009, some of them did lose value due to distress of the counterparty (specifically Lehman Brothers and to some extent Merrill Lynch). Prior to the financial crisis, catastrophe bonds were structured with a total return swap that was intended to minimize credit risk of the collateral (i.e. to isolate and transfer only the insurance risk). The proceeds of the bond issuance were placed in secure trust accounts and were invested in high-quality/highly rated collateral. The collateral was managed by a highly rated counterparty that converted the return on the collateral assets into a benchmark interest rate (typically LIBOR) payable to investors. Overly aggressive management of the collateral account by Lehman, the severity of the credit and liquidity crisis, and Lehman's bankruptcy, resulted in severe distress in certain catastrophe bonds. In the aftermath of the financial crisis, a number of structural enhancements were introduced to make collateral safer. The market seems to have settled on treasury money market funds as the preferred collateral solution thereby significantly reducing credit risk.

catastrophe bonds provide more immediate (i.e. real time) transparency regarding the risk pricing in the broader markets. A reinsurance buyer no longer has to wait for annual renewal discussions to have a realistic sense of market shifts; catastrophe bond pricing provides this. Recognizing drivers of risk pricing outside of insurance provides a savvy reinsurance buyer with information that informs the allocation of purchases across products for optimal pricing and security.

For investors, the case for uncorrelated total returns remains compelling and has persisted over the last two decades as financial catastrophes are fundamentally uncorrelated to natural catastrophes. The correlation of risk premiums, however, during the same period has been greater than zero. All else being equal, a low-yield environment will result in softening reinsurance pricing.

In order to make optimal allocation decisions, a portfolio manager must therefore be able to discern the attributes of pricing trends and to distinguish between those emanating from within and outside the insurance market. Further, a manager must recognize the dangers posed by broader markets to avoid being caught in a liquidity crunch during periods of turmoil by drawing resources from both insurance and debt capital markets to make informed decisions.

Helping you to make more informed capital allocation decisions

PartnerRe provides innovative reinsurance to insurers through both traditional reinsurance solutions and alternative capital solutions including ILS. PartnerRe has managed ILS funds, seeded with its own capital, since 2006 and unlike independent ILS managers, we have a substantial, long-term economic interest in the performance of our funds. PartnerRe controls its exposure to ILS in a manner consistent with its other catastrophe exposure by applying disciplined pricing and underwriting processes and by leveraging PartnerRe's industry-leading modeling, research and underwriting resources to assess risk.

Data source and calculation methodology

Catastrophe bonds spreads data:

- The catastrophe bond spread data is based on secondary market prices and spreads of individual bonds provided by Swiss Re capital markets. The following calculation methodology was used to construct catastrophe bond universe spread time series:
  - Entire universe of natural catastrophe P&C catastrophe bonds issued under rule 144a is considered.
  - No adjustment for seasonality is made. However, all bonds with time to maturity of less than six months are excluded.
  - The spread at a given date is market value weighted average gross spread of the entire P&C catastrophe bonds universe. No risk-adjustment is made.
  - The rolling 12-month average spread on a given day is arithmetic average spread for the prior twelve months.

High-yield corporate bond spreads data:

- Time series of Bank of America Merrill Lynch BB corporate bond index OAS (option-adjusted spreads).

Property catastrophe rate on line index data:

- Guy Carpenter global cumulative property catastrophe rate on line (ROL) data with 1989 ROL chosen as a base of 100 and subsequent years shown relative to this base.

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