# 6
# *Traded Catastrophe and Weather Markets Today*

For decades economists and financial professionals have worked to move insurance-like risks to traded markets, often motivated by the same reasoning I discussed chapter 4. A few of those projects came up in my interviews over and over again. This chapter provides some basic information on those existing catastrophe and weather markets. It provides a context for the interviews that follow in chapter 7. For more detailed treatment of these markets, see Kurtov [2010] and Lane [2012].

## *Natural hazard catastrophe bonds*

A catastrophe bond (CAT bond) is a securitized form of reinsurance risk.[1] They provide large chunks of tail-risk coverage, usually to individual insurance companies. While closely associated with the reinsurance industry, they are regulated and traded like bonds.

In its most simplified form, a CAT bond resembles a normal corporate bond. A bond *sponsor* receives a loan from the bond investors, which they must pay back, usually over the course of three years. The important distinction from a corporate bond is in how the initial loan gets put to work. In the case of a CAT bond, those initial funds are held in escrow until there is a *triggering* event, such as a hurricane of a given magnitude making landfall in a given region (a parametric trigger) or losses in a reinsurance portfolio exceeding a pre-specified level (an indemnity trigger). Setting up those escrow accounts, and establishing rules for how the funds are used while they are in escrow, makes the process of issuing a CAT bond a great deal more complicated than that simple example. But the basic notion holds. Capital markets provide funds that are set aside in the case of a disaster and are compensated by regular payments from the firm receiving coverage. If there is no triggering event, the investor receives both the principal of their loan and the full set of coupon payments. If there is a triggering event, the loan is effectively forgiven and provides the

[1] Unfortunately, the world of financial engineering for catastrophe risk uses overlapping terms to describe itself. CAT bonds are the largest component of Insurance-Linked Securities (ILS), which in turn is form of alternative reinsurance capacity. Alternative reinsurance capacity is itself a subset of Alternative Risk Transfer (ART). Throughout this dissertation I used ILS and CAT bonds interchangeably.

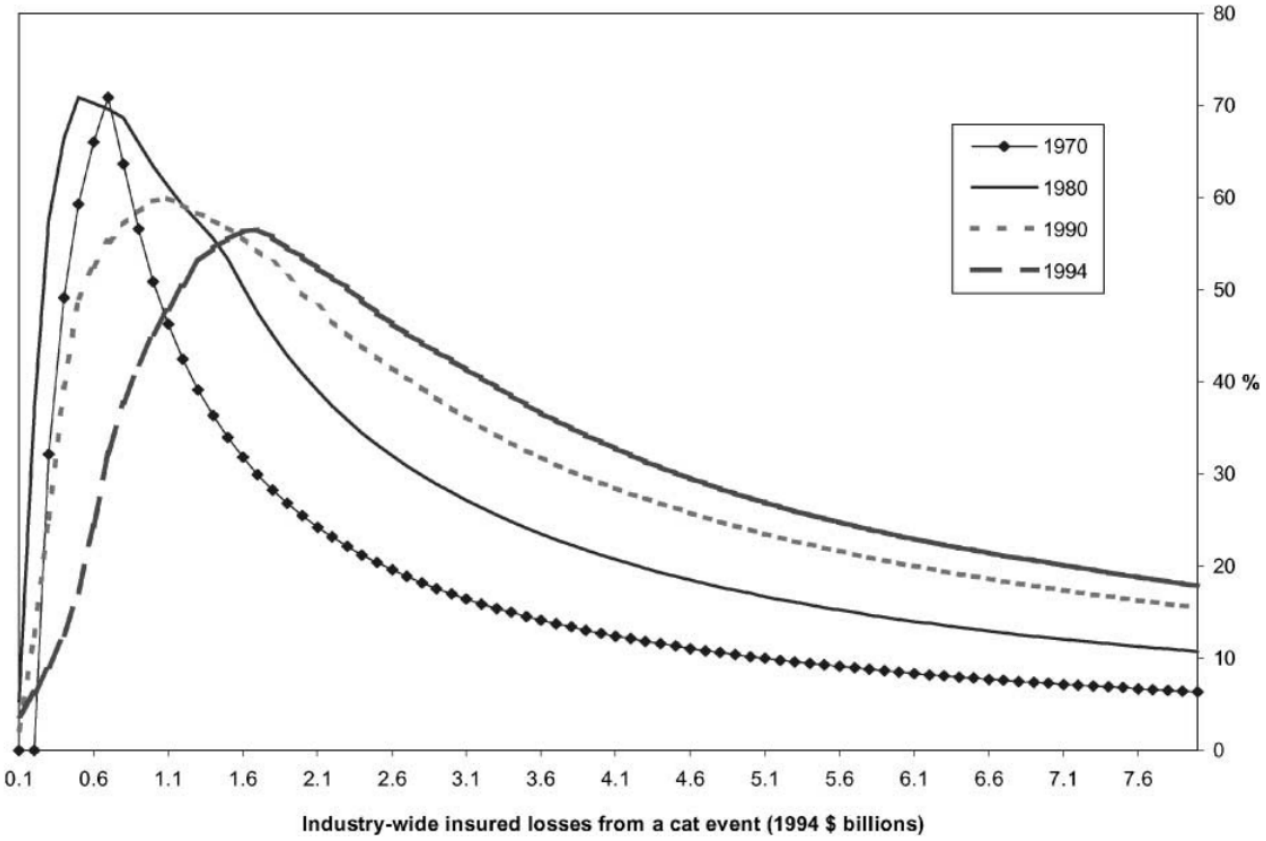


Figure 6.1: *Percentage of exposure that insurance companies reinsure (by various event sizes). This graph shows the amount of a marginal dollar of industry-wide loss that is reinsured against catastrophic losses in a sample of insurance companies that purchase reinsurance through Guy Carpenter & Company* - Figure and caption from Froot [2001]. The long right tail on the graph shows that the industry held less reinsurance coverage for larger impact events.

sponsor with a large, insurance-like payout.

One of the first CAT bonds was issued in 1997 on behalf of the insurance company USAA. Through that deal, dubbed the "bet with God" in the financial press[2], USAA covered remote losses that reinsurers then considered too risky. Figure 6.1 reproduced from Froot [2001] shows how insurance companies like USAA actually had less reinsurance coverage for extreme events that would jeopardize their solvency than for higher-probability, lower-impact events. The long right tail on the graph shows that reinsurance companies *self-reinsured* (i.e. saved) against exactly those extreme risks that would threaten their solvency. USAA was intent on obtaining that extreme coverage and was willing to wait though a four year development process for its first CAT bond, probably at significant cost to the firm.

[2] L.R. Quinn. Weather bonds from Enron, Koch to debut today, November 1 1999

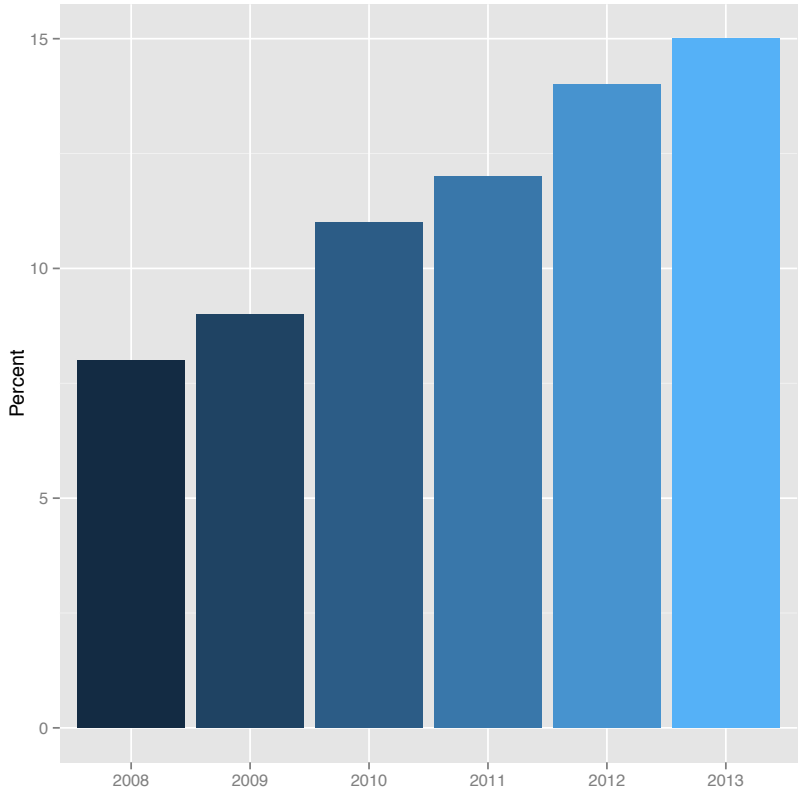


Figure 6.2: Alternative reinsurance capacity as a percentage of global property catastrophe reinsurance limit. Data from Guy Carpenter Capital Ideas Editor [2013] via Evans [2013].

Since the first CAT bond transactions in the late 1990s, the market for alternative reinsurance capacity, which includes instruments like collateralized reinsurance and sidecars as well as insurance-linked securities (ILS) like CAT bonds, has grown to roughly 15 percent of the overall reinsurance market. Figure 6.3 shows that CAT bonds are the largest single source of alternative reinsurance capacity, at $\tilde{5}$ percent of total reinsurance capacity. The ILS market now has an

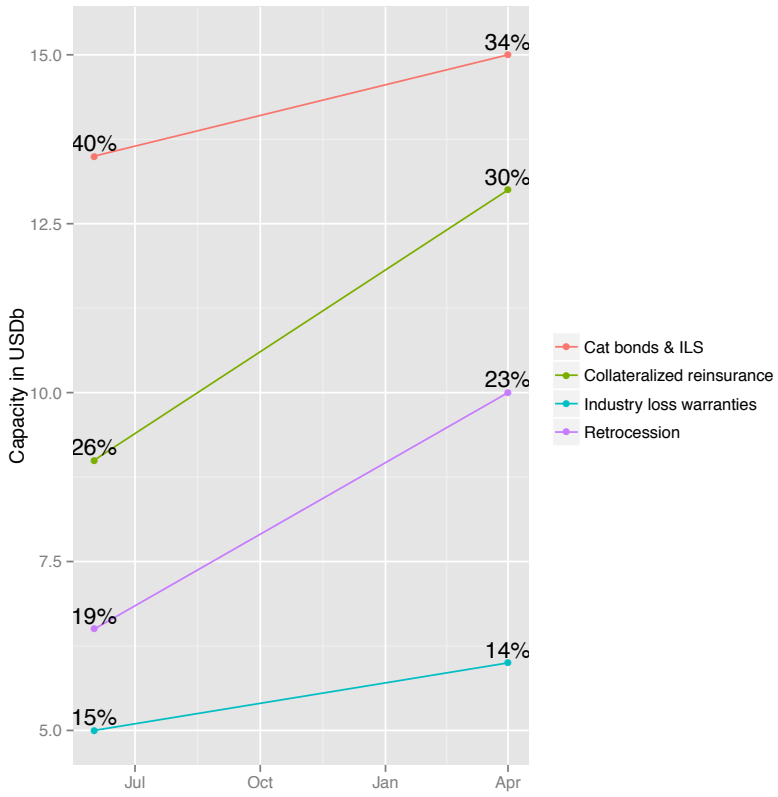


Figure 6.3: Alternative reinsurance capacity by type (in USB billion and percentages.) Data from Flandro and Mowery [2012] and Evans [2013].

outstanding notional value of roughly USD 17 billion (see figure 6.4). At those levels, CAT bond markets sustain a niche of asset managers dedicated to catastrophic risk, as shown in figure 6.5.

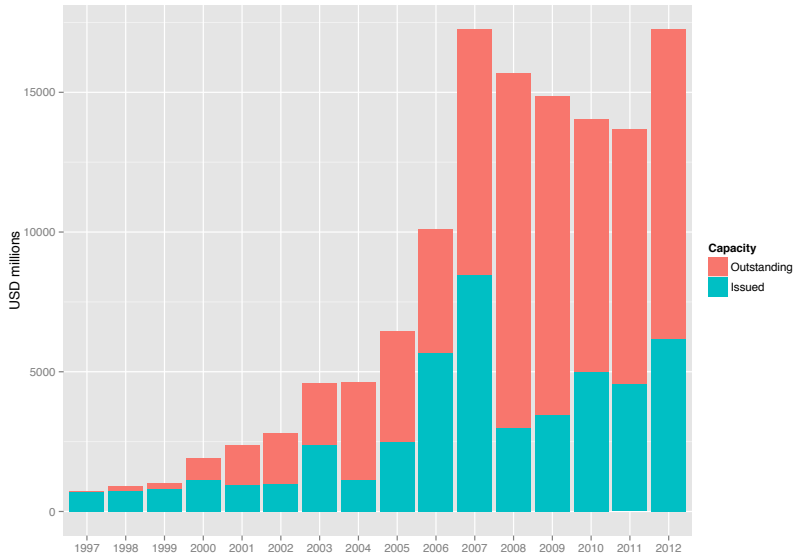


Figure 6.4: Total ILS outstanding as of July 2012. Data from Swiss Re Capital Markets and Bisping [2012].

While the initial transactions were meant to augment reinsurance coverage, CAT bonds have become an alternative to reinsurance in some cases. Some industry insiders believe that the competition created by CAT bonds may change the pricing cycle that has defined reinsurance in recent decades. After a major loss, reinsurance prices have tended to skyrocket. Froot [1999] linked that cycle to shortfalls in the capital available for reinsurance.

CAT bonds may change that cycle by providing an avenue for firms in capital market firms (like hedge funds) to enter the reinsurance industry. In general, CAT bonds are fully collateralized, meaning that all the money needed to pay on the covered claims is set aside at the initial bond auction. Thanks to that arrangement, CAT bonds theoretically free of counter-party risk, allowing anyone to provide reinsurance coverage, even if they are not regulated as a reinsurance company. (Since the money in escrow is invested, there is the opportunity for poorly structured deals to introduce counter-party risk into CAT bond transactions. Following Lehman Brothers' collapse, CAT bonds that invested their collateral in Lehman-backed swaps meant to simulate safe investments were indeed threatened by counter-party default[3].) Capital markets have embraced CAT bonds in recent years, attracted by steady returns uncorrelated to the market.

Figure 6.5 shows how capital markets have gradually accepted catastrophic risk. Institutional investors have entered the market di-

[3] A. Kurtov, editor. *Investing in Insurance Risk: Insurance-Linked Securities - A Practitioner's Perspective*. Risk Books, June 2010

rectly, and indirectly through their stakes in dedicated catastrophic risk funds. Gradually institutional investors, hedge funds, and dedicated ILS funds (whose ownership often overlaps with, for example pension funds placing capital in hedge funds that in turn have a stake in a dedicated ILS fund) have replaced traditional reinsurers in the ILS market. Recently, the private equity and buyout giant Kohlberg Kravis Roberts acquired a 25 percent stake in one of the two largest CAT bond investment managers, Nephila[4]. Chief executive officer of Berkshire Hathaway's General Re, Franklin "Tad" Montross, recently summed up that interest from institutional investors in CAT bonds[5]:

> With interest rates being where they are, I don't think it's a surprise that a CAT bond with a yield of 350 or 500 basis points over LIBOR looks attractive. People are drooling for those.

[4] Leslie Scism and Ryan Dezember. KKR agrees to buy stake in Nephila Capital to add returns from catastrophe reinsurance, January 23 2013

[5] Noah Buhayar and Charles Mead. Drooling cat-bond investors overlook risk, montross says, June 6 2013. URL http://www.bloomberg.com/news/2013-06-06/drooling-cat-bond-investors-overlook-risk-montro html

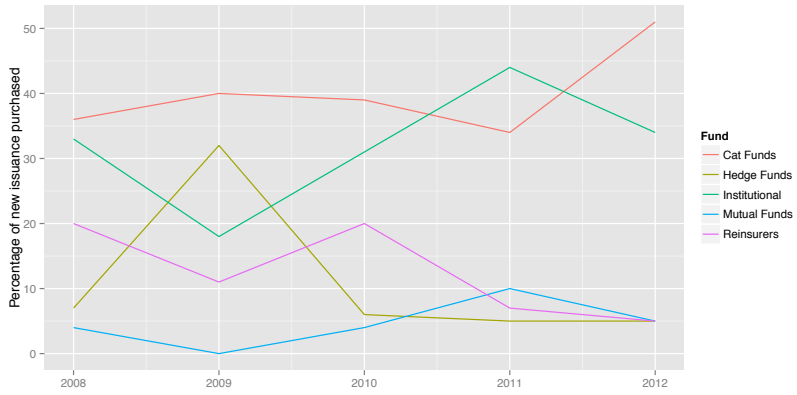


Figure 6.5: New CAT bond issuance purchase by investor type. Data from Schultz [2012].

Despite that influx of new capital, the use of CAT bonds continues to mirror reinsurance, particularly in the way they concentrate on *peak perils*. In figure 6.6 we see how the roughly USD 17 billion in outstanding CAT bond capacity was divided among perils. [6] The market remains highly concentrated in a few risks, particularly US hurricanes.

[6] I provide my own estimate of peril by peril issuance in figure 2.11. That estimate makes some attempt to divide up *multi-peril* deals into their consituent parts, so the graph shows a much higher concentration in US hurricane risk than 6.6.

The industry's concentration of CAT bond capital in hurricane risk is also clear looking at the price differential between CAT bond coverage with and without US wind exposure. In 6.7, we see that investors are clearly willing to accept a lower return on risk that diversifies their portfolios. That gap has grown in recent years, perhaps due to the presence of dedicated funds who use portfolio-oriented risk management strategies.

Initially, many believed that CAT bonds would lead to greater standardization within catastrophic risk markets. Markets finally had a means of rewarding insurance companies who were willing to accept some basis risk, because investors would gladly offer a lower price for

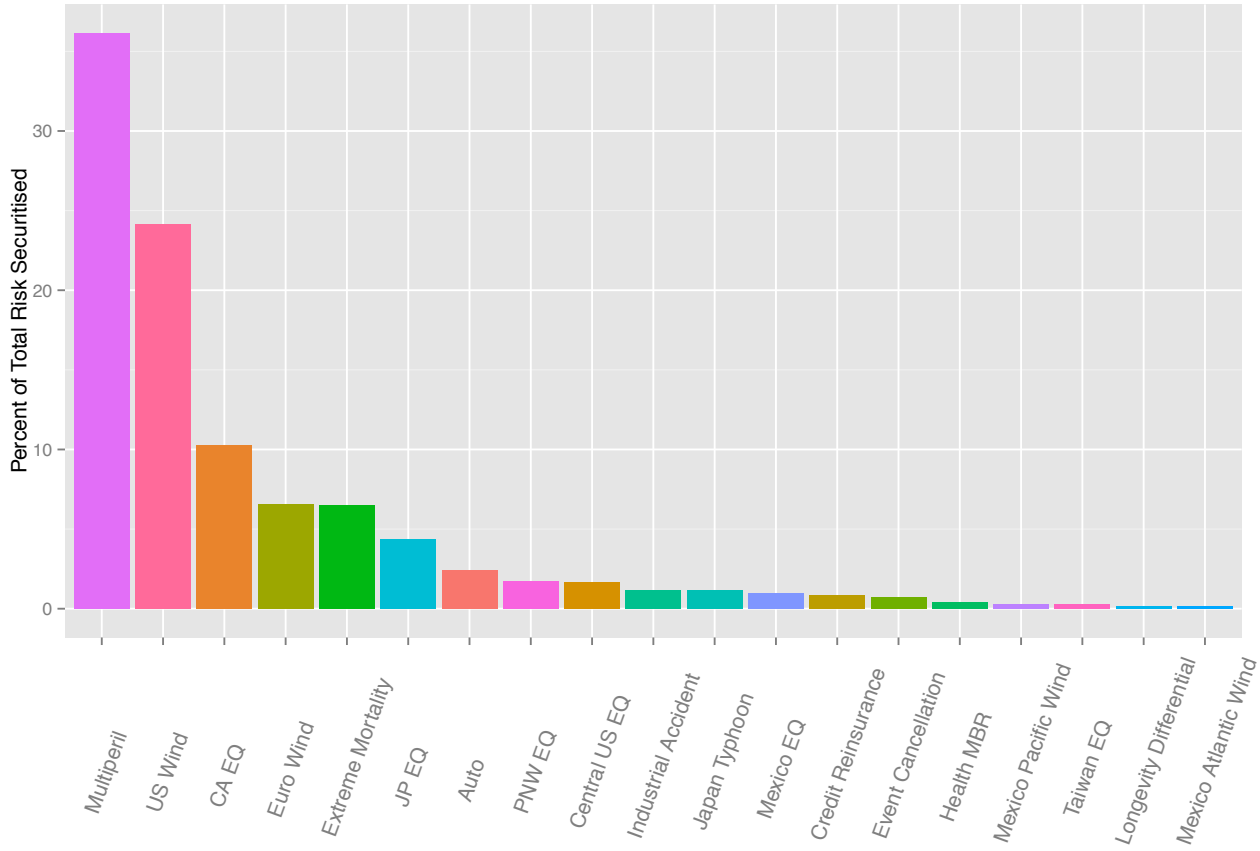


Figure 6.6: Perils by total risk securitized in millions as of May 2011. Data from Swiss Re [2011].

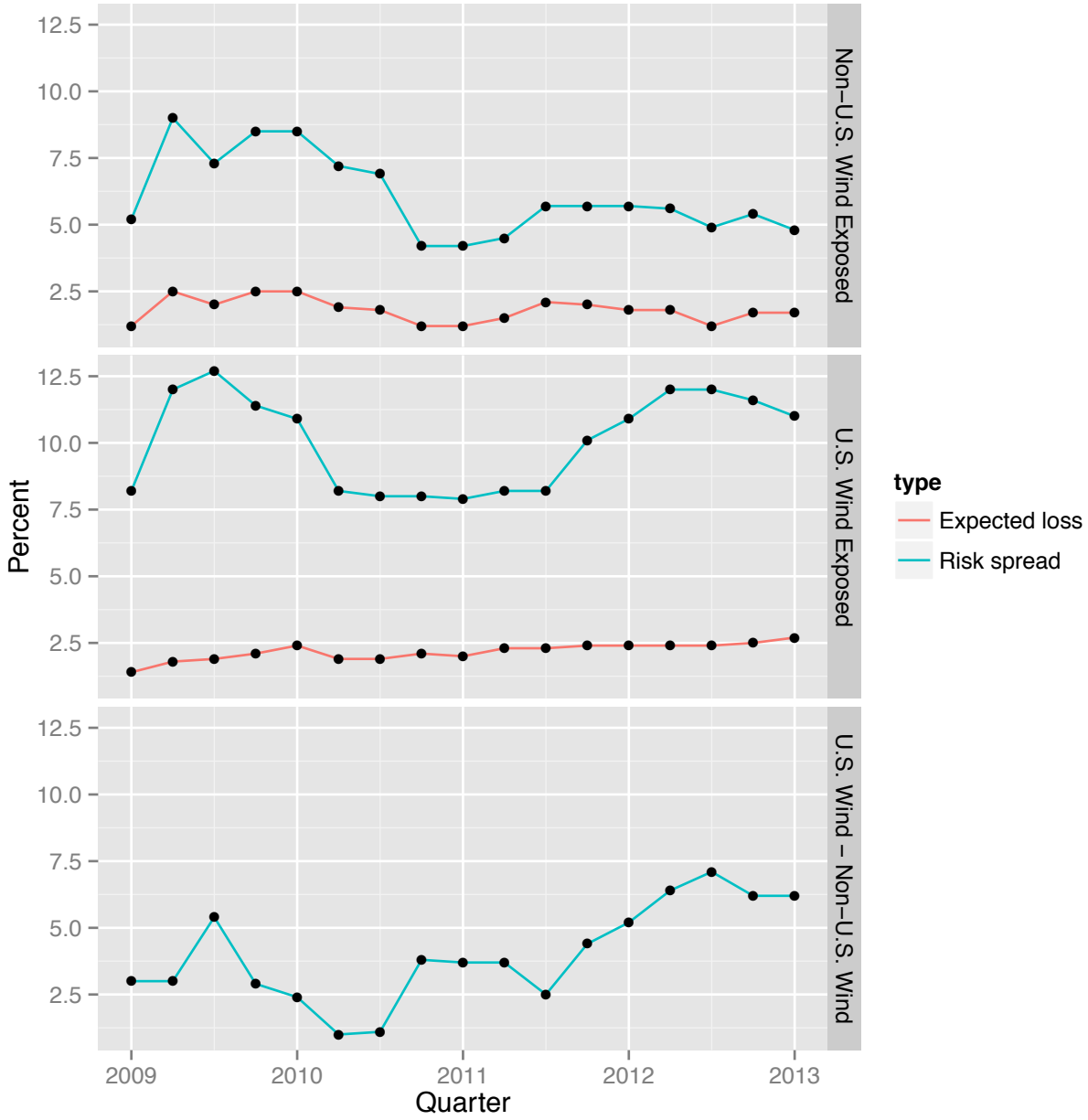


Figure 6.7: Willis Capital Markets & Advisory weighted average risk premium and expected loss on an index of CAT bonds over last 12 months. Data from Ursano [2013].

relatively simple triggers with little moral hazard. In fact, the market has not systematically become standardized. One reason why insurers have accepted CAT bonds as a substitute for reinsurance is that investors have been willing to accept the same type of indemnity triggers common to traditional reinsurance. That trend toward indemnity triggers is clear in figure 6.8.

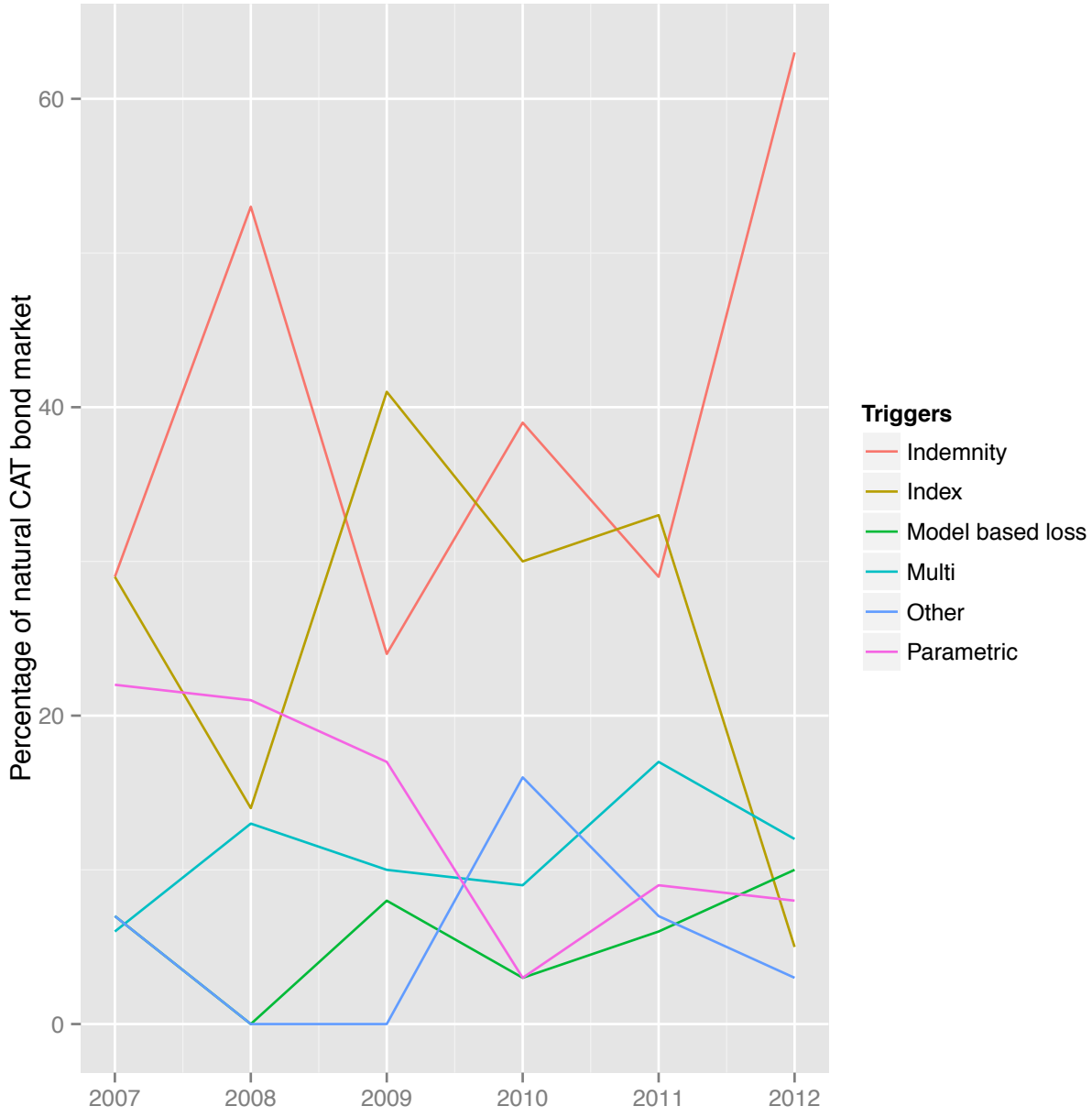


Figure 6.8: Natural catastrophe bonds by trigger type as of August 2012 (includes only natural catastrophe, excludes life, health, and sidecars.) Data from Millette [2012].

After an initial offering period, most CAT bond investors simply hold their notes to maturity. However, there is a relatively small *sec-*

*ondary* market in which investors rebalanced their portfolios and new entrants buy exposure when new issues are scarce. In 2011, that secondary market traded CAT bond notes of roughly USD one billion. Since some of those trades represent the same note changing hands multiple times, it is difficult to say how much of the total USD 17 billion in CAT bonds trade on the secondary market. Figure 6.9 shows secondary CAT bonds trading between 2010 and early 2012. It is difficult to draw conclusions from two years of data, but despite its lumpy trading within the sample, overall secondary trading volumes grew year on year from a volume of 792 in 2010 to 999 in 2011.

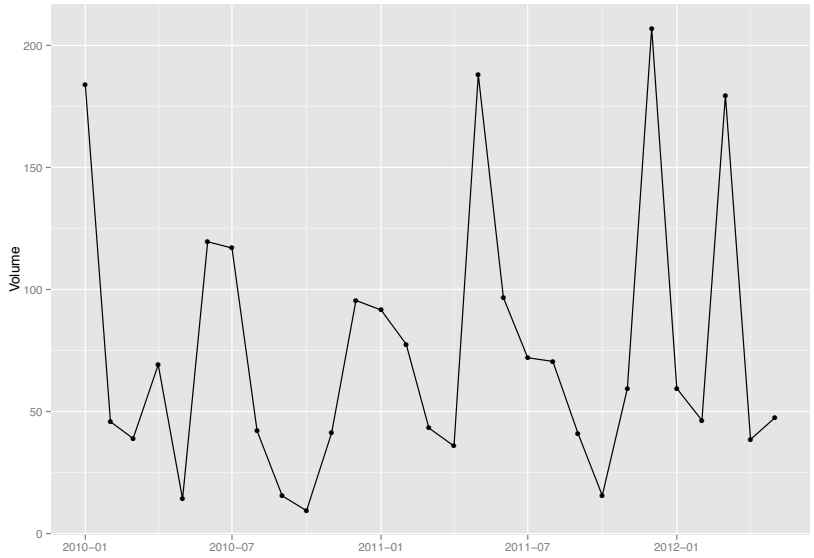


Figure 6.9: Secondary trading volume for ILS. Data from Swiss Re [2011].

## *Weather derivatives*

Another market relevant to ENSO is that for weather derivatives. Weather derivatives involve payments contingent on an index of weather data such as the temperature or rainfall at a given weather station. The Weather Risk Management Association (WRMA), the main industry association for weather risk professionals, estimates that the total notional value of weather derivatives traded in 2011 at roughly USD 12 billion[7].

Figure 6.10 provides WRMA's estimates for the notional value traded based on press releases related to their semi-annual member survey[8]. It shows that weather trading grew rapidly in the run-up to the 2007-2008 financial crisis, crashed, and has yet to recover to pre-crisis highs. Figure 6.11 tells the same story using volumes on the CME's weather derivatives contracts (futures, options, and cleared swaps) with the ten largest contracts by 2011 volume highlighted.[9]

[7] That figure is not directly comparable to the USD 17 billion for CAT bonds, since it is the notional value traded, not the notional volume outstanding. In the parlance of capital markets the USD 17 billion for CAT bonds is open interest, while the USD 12 billion for weather derivatives is volume.

[8] WRMA press releases, 2013. URL http://www.wrma.org/pressroom.html

[9] The CME dominates the weather trading market.

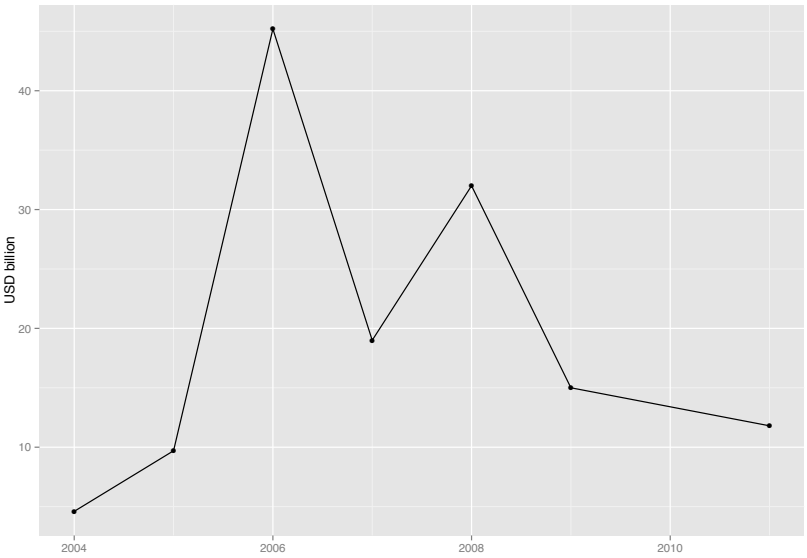


Figure 6.10: Notional trading volume of weather derivatives. Data from wrm [2013].

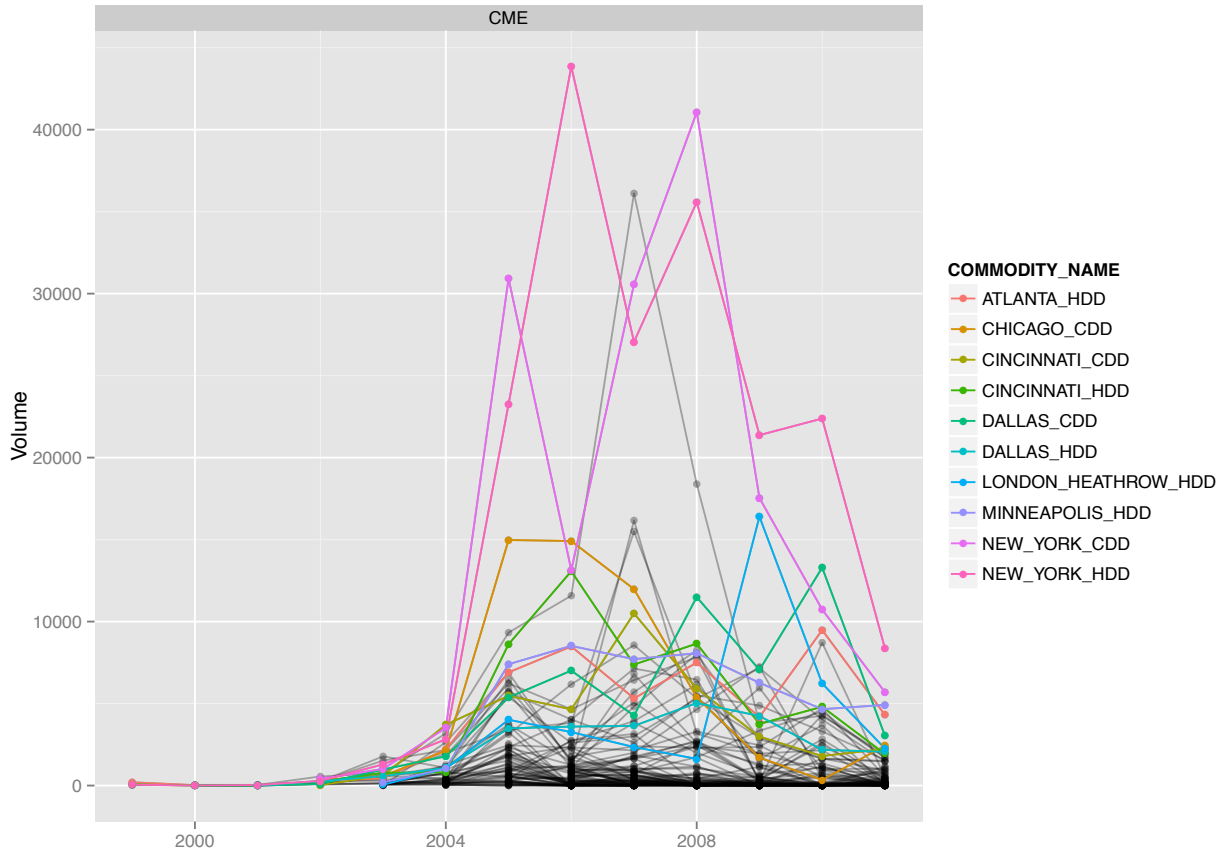


Figure 6.11: CME weather derivative trading volume by contract. The ten most popular contracts by 2011 trading volume are highlighted.

Weather derivatives markets began in the late 1990s. According to Aquila Energy, one of the field's pioneers, El Niño's weather volatility played a central role in the market's development[10]:

> The weather derivative market was jump started during the El Niño winter of 1997/1998, one of the strongest such events on record. This event was unique in terms of the publicity that it received in the American press. Many companies, faced with the possibility of significant earnings declines because of an unusually mild winter, decided to hedge their seasonal weather risk.

[10] Geoffrey Considine. Introduction to weather derivatives. Technical report, Weather Derivatives Group, Aquila Energy, 2000. URL http://www.cmegroup.com/trading/weather/files/WEA_intro_to_weather_der.pdf

Given that historical connection, the close attention that today's weather traders pay to ENSO forecasts, and the indexed-nature of the phenomenon itself, it is easy to see why many of the industry professionals I interviewed suggested that ENSO markets should and would be traded as a weather derivative.

Two large energy firms, Koch Industries and Enron, pioneered the field of weather derivatives, offering investors specialized transactions based on weather station data in the late 1990s. A catastrophe risk specialist involved in those early transactions suggested in my interviews that one of these leading firms had special information on the history of the weather data used to settle the contracts. That information skewed the odds of payouts in the firm's favor.

If indeed asymmetric information was a factor in early transactions, then investors caution was warranted. In 1999, both Koch and Enron contracted investment banks, Goldman Sachs and Merrill Lynch respectively, to help them move their creations to bond markets[11]. The Enron bond offer was aborted after it failed to attract sufficient investor interest, in part because prospective investors did not believe they had the expertise to trade weather competently[12].

[11] L.R. Quinn. Weather bonds from Enron, Koch to debut today, November 1 1999

[12] L.R. Quinn. A tepid response puts weather bonds on ice for the moment, January 24 2000

Enron's bankruptcy represented a major setback for weather market liquidity. Shortly before the firm's failure, some estimated that the firm represented as much as 30 percent of overall trading on weather markets[13]. Indeed, multiple weather traders independently lamented that Enron's collapse set the market back "ten years," according one interview subject. Nevertheless, volume on the CME's weather contracts grew through the mid-2000s, as is clear in 6.11. Energy firms, particularly natural gas firms, continue to dominate trading to this day. As I discuss in chapter 7 few of those firms consider weather risk a growth market at the center of their strategic plan, the way Enron did[14].

[13] Ian Springsteel. Enron leads the weather pack, January/February 1999

[14] Bethany McLean and Peter Elkind. *The Smartest Guys in the Room: The Amazing Rise and Scandalous Fall of Enron.* Portfolio Trade, 2004

After the global financial crisis, weather derivatives volumes crashed (see figure 6.10.) Even including OTC trading, notional volumes are a fraction of their pre-crisis peak. That trend, combined with the divestment of large banks from commodity trading in general, and the abundance of natural gas (the commodity most closely linked to

weather trading), particularly in the US, has led many large banks and hedge funds (including Morgan Stanley and Citadel) to shutter their weather desks in recent years[15,16].

[15] The Economist. America's cheap gas: Bonanza or bane. *The Economist*, March 2 2013b

[16] The Economist. Fixed income, currencies and commodities: A ficc for your trouble. *The Economist*, May 11 2013c

### *CAT derivatives*

Distinct from weather, catastrophe derivatives offer a more complicated precedence for ENSO markets, one marked by multiple rounds of innovation that never managed to achieve sustainable on-exchange liquidity.

The first round of innovation predates both CAT bonds and weather derivatives. It was hosted by the Chicago Board of Trade, with reported volume between 1992 and 1994. Figure 6.12 shows volumes for those contracts. They settled on indexes of reinsurance industry losses. At the time, reinsurance professionals viewed those indexes with suspicion. However, in the intervening years many CAT bonds, reinsurance agreements, and industry loss warranties settled on similar indexes. At least one industry expert I interviewed believes that, given the familiarity of industry professionals with those indexes, the CBOT contracts would have stood a much better chance had they been first launched today.

As Sandor [2012] details, the index was not the only problem with those early contracts. In particular, the CBOT contracts launched as futures which, as I discussed in chapter 3 are a poor structure for catastrophic losses. (Although, they may be entirely appropriate for industries with very low basis risk and special index expertise.) Only after the futures struggled did the CBOT introduce options.

Exchange-traded catastrophe derivatives were reborn almost a decade later. The CME's suite of contracts were developed by the reinsurance brokerage Carvill and first offered in 2006. Most of the contracts settle on the Carvill Hurricane Index, a purely parametric measure of hurricane impacts over specific regions. The risk modeling firm EQECAT is in charge of calculating the index using NOAA data and is responsible for providing alternative data when NOAA figures are not available[17]. As I mentioned in chapter 3, indicative prices on the contracts' marketing materials suggest a modest, but unstable pricing advantage for hedgers choosing these markets over reinsurance or ILS. Despite being offered on an exchange, most of the trading is bilateral either as block trades or OTC swaps. Also while the CME offers a range of structures including futures, my interviews indicate that virtually all trading trading to date has been in the form of binary options.

[17] A. Kurtov, editor. *Investing in Insurance Risk: Insurance-Linked Securities - A Practitioner's Perspective*. Risk Books, June 2010

Figure 6.13 shows trading volumes for contracts in a competing suite launched on IFEX, an exchange associated with the Chicago

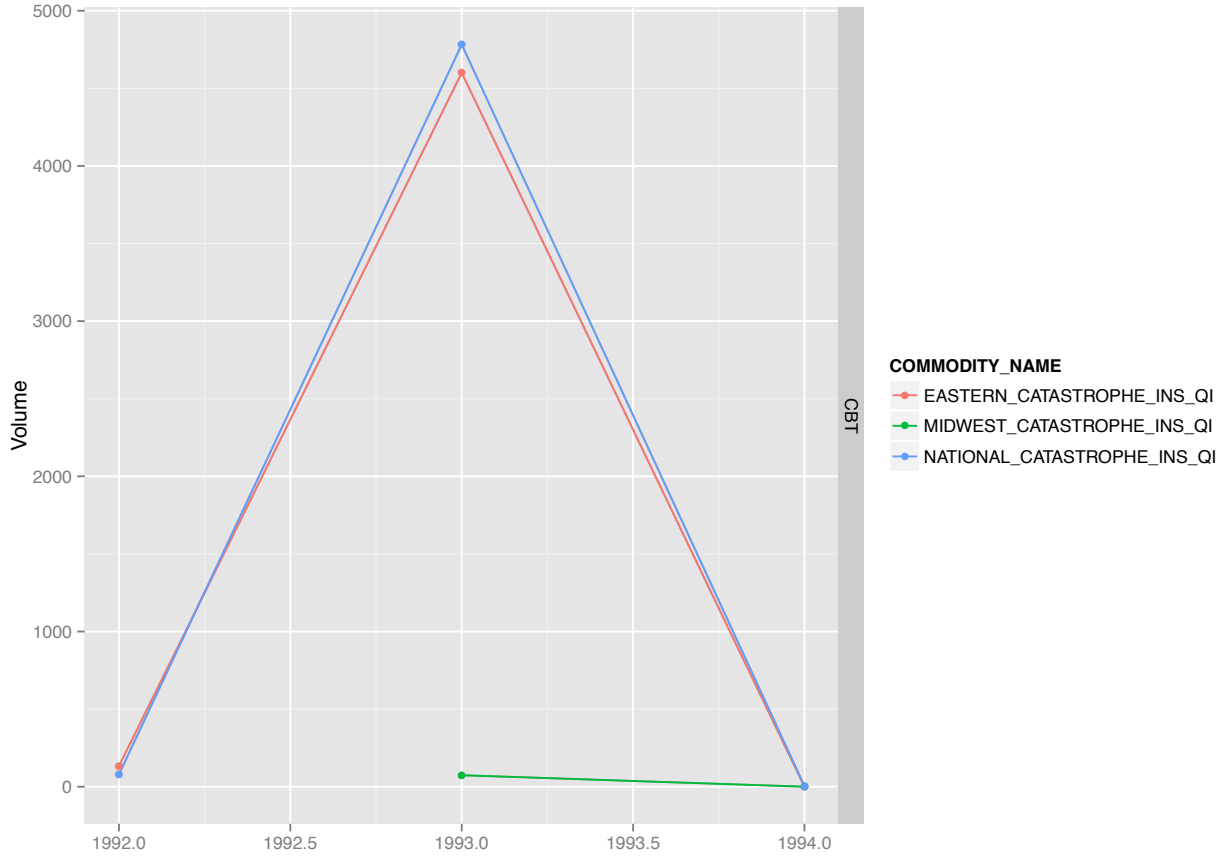


Figure 6.12: CBOT catastrophe derivative trading volume by contract.

Climate Exchange (CCX). IFEX catastrophe contracts follow the same pattern as the weather derivatives in figure 6.11, with a peak before the financial crisis, a crash, and a modest recovery for some contracts. Both the IFEX contracts and those launched in 2009 on EUREX, attempt to mimic ILWs, settling on an index of industry-level losses over specific regions[18].

Kurtov [2010] suggests that the total notional value of catastrophe derivatives and ILWs for property and casualty risk (i.e. excluding mortality or longevity) is between USD 5 and 10 billion. Estimates from reinsurance broker Guy Carpenter (figure 6.3 and Manning [2012]) place ILWs' contribution between USD 5 and 6 billion. Only a few of the firms I interviewed actively use catastrophe derivatives, while most trade ILWs. Both the estimates and the anecdotal evidence from interviews suggest that catastrophe derivatives represent the smallest market discussed here.

[18] A. Kurtov, editor. *Investing in Insurance Risk: Insurance-Linked Securities - A Practitioner's Perspective*. Risk Books, June 2010

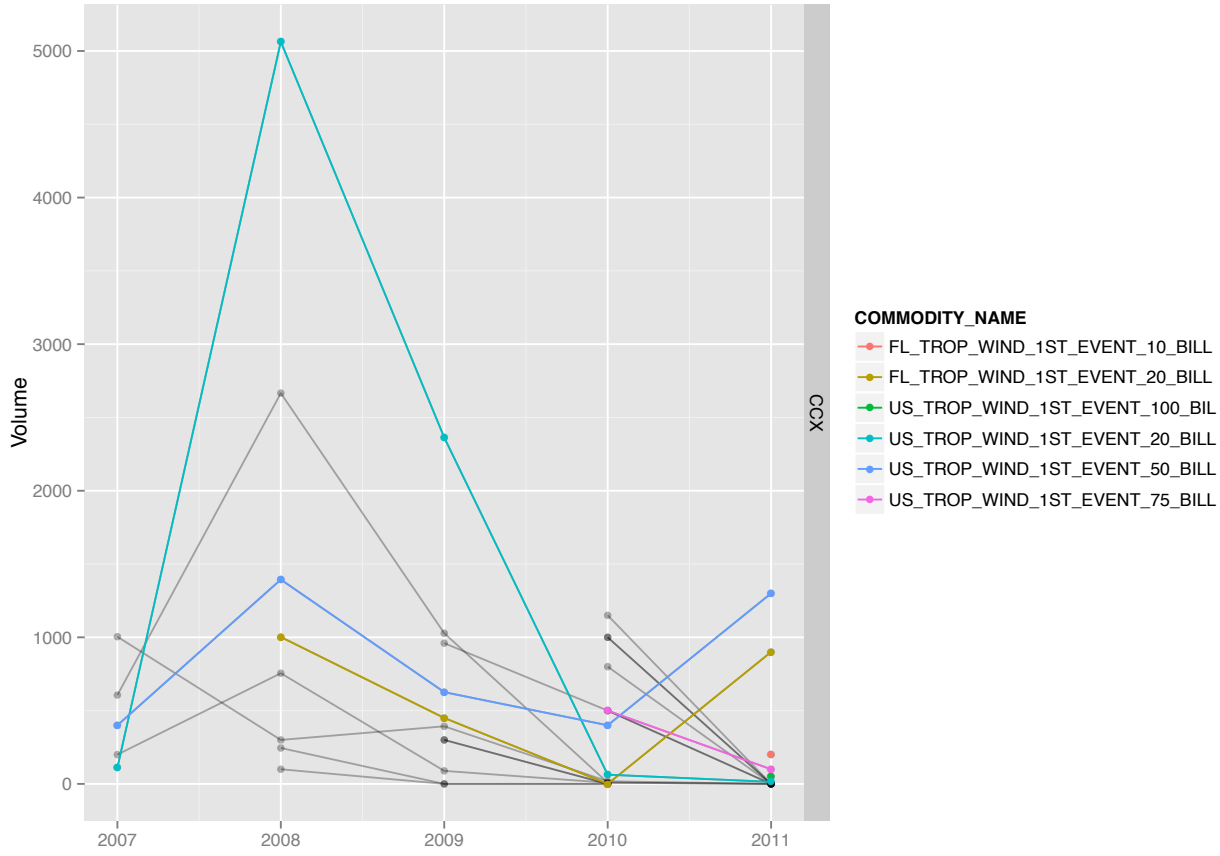


Figure 6.13: IFEX/CCX catastrophe derivative trading volumes by contract. The six contracts in the sample with positive 2011 trading volume are highlighted.