

Twelve Capital Research Spotlight – Hurricane Season 2017

This year's hurricane season was an eventful one, most notably with three significant North Atlantic hurricanes impacting various regions of the US and parts of the Caribbean in relatively quick succession. Records were also set, with Hurricane Irma, for instance, exhibiting wind speeds of above 300km/h for a period of more than 37 hours.

The catastrophe bond market experienced significant volatility during a number of these events, with some bond prices suffering double-digit losses, but recovering considerably since. Having said this, many bonds are still trading below par for the time being, as discussed in greater detail below.

In our view, the likely repricing in reinsurance and catastrophe bond markets over the coming months should provide investors with an opportunity to take advantage of higher insurance premiums going forward. Furthermore, the upcoming new issuance season should allow capital to be deployed quickly into a market that can, on occasion, be less liquid during other periods of the year.

Summary

An exceptional year

To date, 2017 has been a rather eventful and somewhat unusual year in terms of natural catastrophes. Hurricane Harvey, for instance, was the first major hurricane¹ making landfall in the US since Wilma in 2005 and was soon followed by two further significant North Atlantic hurricanes, which impacted various regions of the US and the Caribbean causing severe damage and loss of life.

Whilst Hurricane Irma was bearing down on Florida, a significant 8.1 magnitude earthquake struck southern Mexico. Although not correlated, it is still unusual to have two such extreme natural catastrophes occurring almost simultaneously. Furthermore, and only 11 days later, a magnitude 7.1 earthquake hit Mexico City causing substantial economic damage and loss of human life whilst, at the same time, Hurricane Maria made landfall in Yabucoa, Puerto Rico as a category 4 storm with winds of 250km/h.

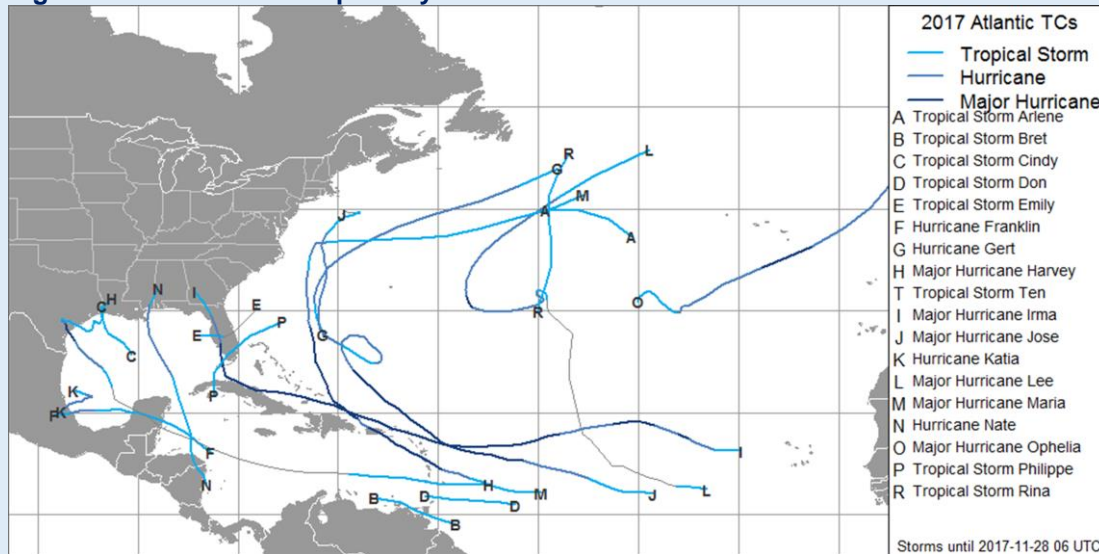
During October, Hurricane Ophelia became the first storm to make landfall in Ireland since 1961 whilst, back in the US, wildfires began spreading in California. A dry summer had created favourable conditions for such an event, which was exacerbated by "El Diablo" winds, and these wildfires could turn into the most expensive in the history of the state as a result.

¹ Major hurricane classified as category 3 or higher.

Reviewing the 2017 hurricane season

The tracks of all Atlantic tropical cyclones observed in 2017 to date are shown in figure 1.

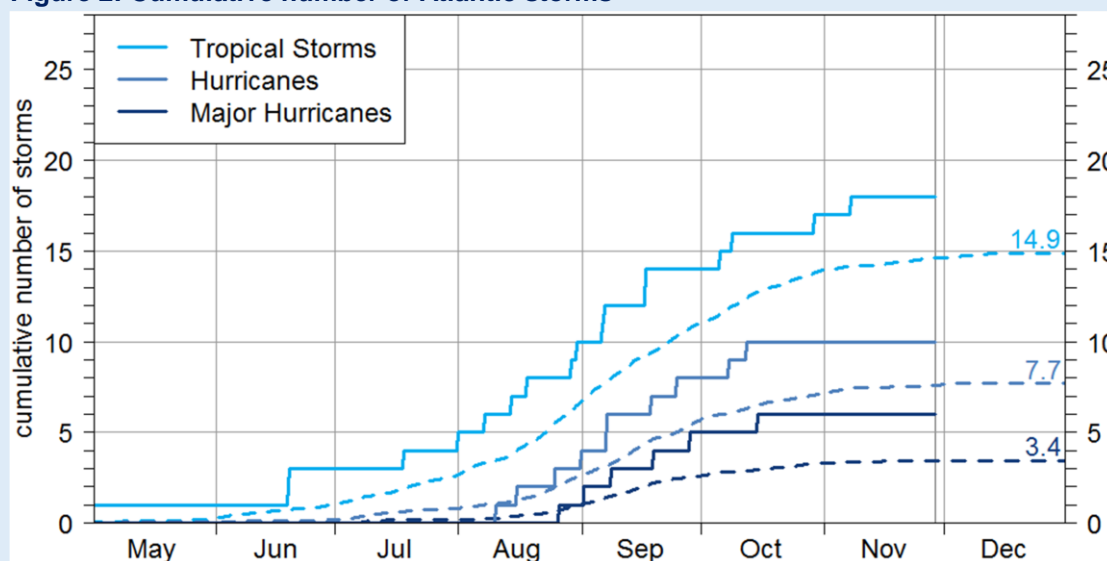
Figure 1: 2017 Atlantic tropical cyclones



Source: Twelve Capital, ILS Analytics. US National Oceanic and Atmospheric Administration (NOAA).

The actual number of storms occurring this season is illustrated by the stepped lines in figure 2. Compared to the prediction of three major hurricanes, shown by the dotted lines in figure 2, the season was far more active than anticipated, with six major hurricanes in total.

Figure 2: Cumulative number of Atlantic storms

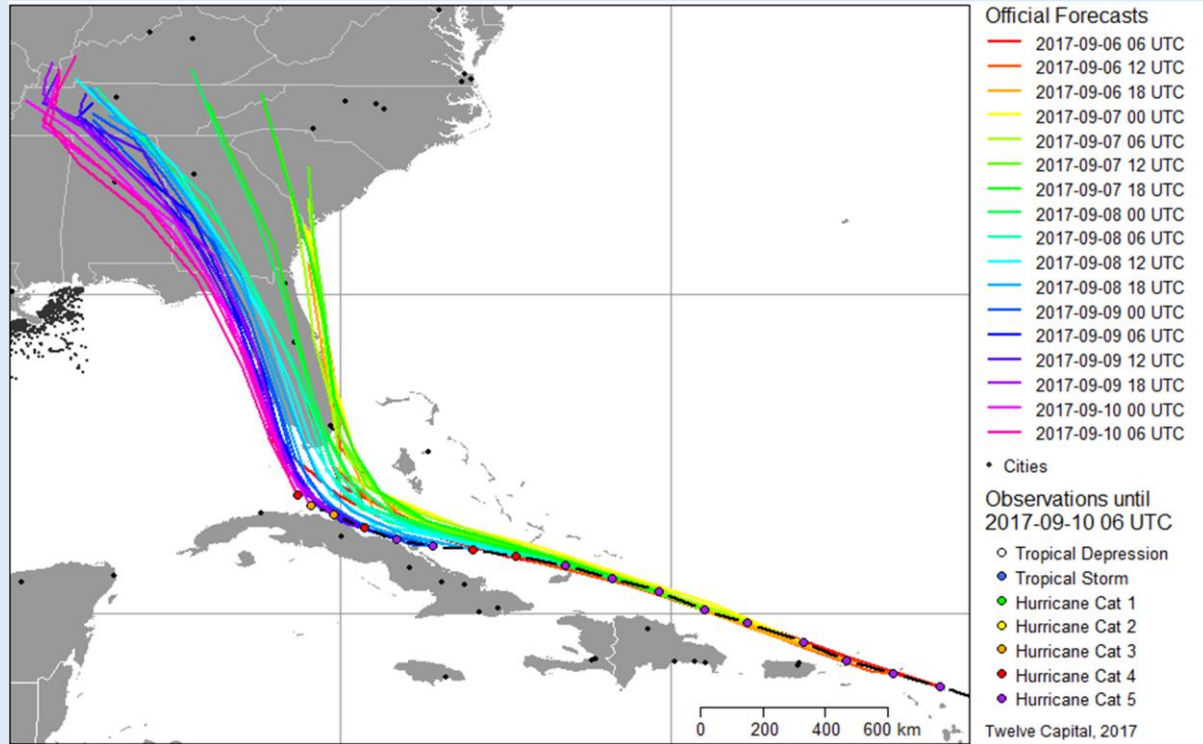


Source: Twelve Capital, ILS Analytics. US National Oceanic and Atmospheric Administration (NOAA).

Harvey: The first major event of the 2017 season was Hurricane Harvey, which “stalled” over downtown Houston during August and resulted in significant levels of flooding. Harvey caused 132cm of rain to fall in the region over 5 days, inundating poorly drained urban areas. Furthermore, the growth of Houston in recent decades only exacerbating the situation, with structures having been constructed in flood-exposed regions. Indeed, this is a pattern seen globally, as population densities increase across coastal cities.

Irma: During September, Hurricane Irma made landfall in parts of the Caribbean and US, setting a record for having the second highest Atlantic Accumulated Cyclone Energy (ACE) ever recorded. Furthermore, with 37 hours of 300km/h winds in the Atlantic Ocean, Irma also took the world record for highest sustained wind speeds. Although Irma was initially forecast to directly hit Miami on 7 September as a category 5 hurricane (indicated by the yellow and green lines in figure 3), eventually the storm's track shifted west and Irma made landfall in the Florida Keys as a category 4 hurricane. Afterwards, Irma made a second landfall south of Naples as a category 3 storm and then weakened significantly over land to a category 1 storm.

Figure 3: Hurricane Irma: forecast variability between 6-10 September 2017



Source: Twelve Capital ILS Analytics, US National Oceanic and Atmospheric Administration (NOAA).

Maria: To round off the trio, Hurricane Maria hit Puerto Rico on 20 September as a category 4 hurricane, bringing extreme devastation and hardship to the island. Maria was the strongest hurricane to hit the country since 1928, and the costliest ever for Puerto Rico.

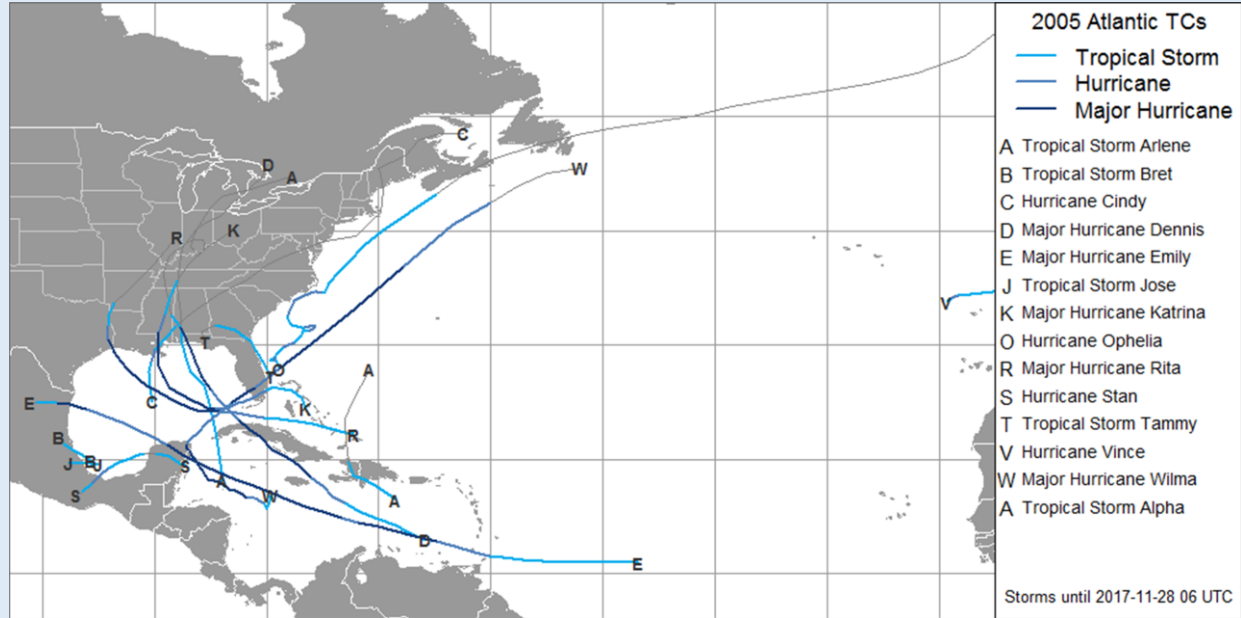
Several reinsurance companies, including Swiss Re and Munich Re, estimate that the insured industry losses from Hurricanes Harvey, Irma and Maria could exceed USD 100bn². An annual exceedance probability of around 2.5% would be implied, meaning that a hurricane season with as much insured industry losses as the one witnessed in 2017 would occur only once every forty years.

² http://www.swissre.com/media/news_releases/nr_20171020_swissre_harvey_irma_maria_losses.html

Comparing 2017 to previous seasons

During the 2005 hurricane season there was also a trio of large loss events including, most memorably, Hurricane Katrina. Interestingly, visually comparing the tracks of the 2017 season (figure 1) against the 2005 season (figure 4), highlights several “parallel” hurricane paths. In 2005, the tracks were more dispersed, as might be expected in a typical season.

Figure 4: 2005 Atlantic tropical cyclones



Source: Twelve Capital, ILS Analytics. US National Oceanic and Atmospheric Administration (NOAA).

Comparing statistics for the 2017 and 2005 hurricane seasons (table 1), highlights some remarkable similarities, both in terms of meteorological data and insured losses.

Table 1: 2017 Hurricane season compared to 2005

Statistic	2017	2005
ACE, % median (1981-2010)	241%	270%
Economic loss (2017\$, bn)	300 (estimate)	285
Insured Loss (2017\$, bn)	130 (estimate)*	149
Top 3 Hurricanes (2017\$, bn)	100 (estimate)*	117**
Hurricanes	10	15
Major hurricanes (Cat. 3+)	6	7

Source: Twelve Capital ILS Analytics, NOAA, Swiss Re, Munich Re.

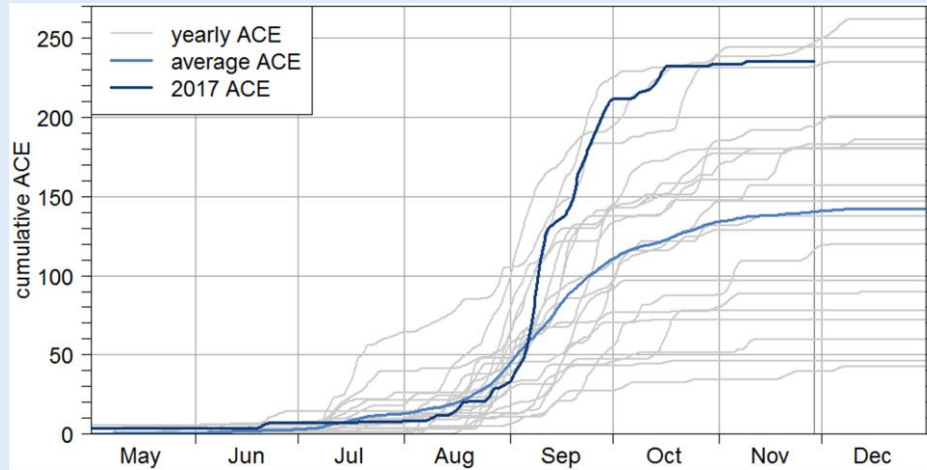
* Estimate for Harvey, Irma & Maria

** Katrina, Wilma & Rita

Climatological outlook

Accumulated Cyclone Energy is a measure of the number, strength and duration of all tropical storms. Pre-Irma, the Atlantic’s Accumulated Cyclone Energy (ACE) was on track for an “average” season as outlined in figure 5. Irma alone had a significant impact on ACE, pushing it far above average, whilst Maria made the season one of the most “energetic” ever. It is worth noting that ACE is a poor indication of insured losses, as not all hurricanes make landfall, and not all land falling events cause losses.

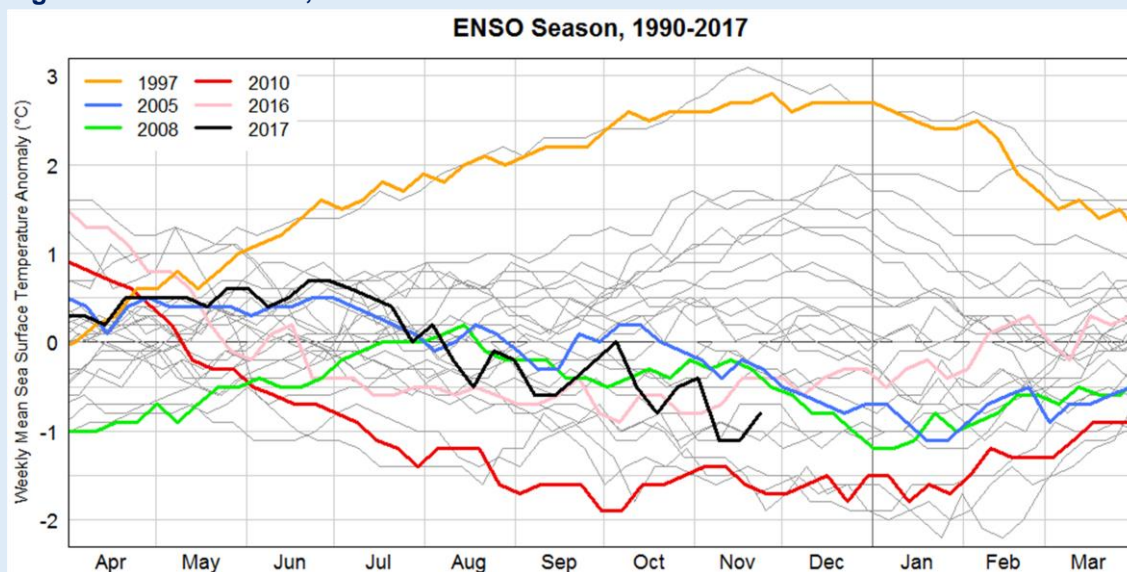
Figure 5: Atlantic Basin Accumulated Cyclone Energy (ACE)



Source: Twelve Capital, ILS Analytics. US National Oceanic and Atmospheric Administration (NOAA).

El Niño/La Niña are terms used to describe certain weather patterns following variations in ocean temperatures. El Niño is currently “neutral”, as demonstrated in figure 6. This means any of the “characteristic” events associated with a negative or positive phase are not expected at this time. The research and theory suggests that during a positive El Niño year, the Atlantic experiences increased wind shear and thus fewer tropical storms. However, although there is correlation between ENSO (El Niño Southern Oscillation, the underlying system resulting in El Niño) and major hurricane activity, the link is weak. Many other factors also have a significant influence on storm formation, landfall and, ultimately, losses. There is little to no forecast skill in ENSO, meaning it is not particularly useful in predicting the number of Atlantic tropical storms.

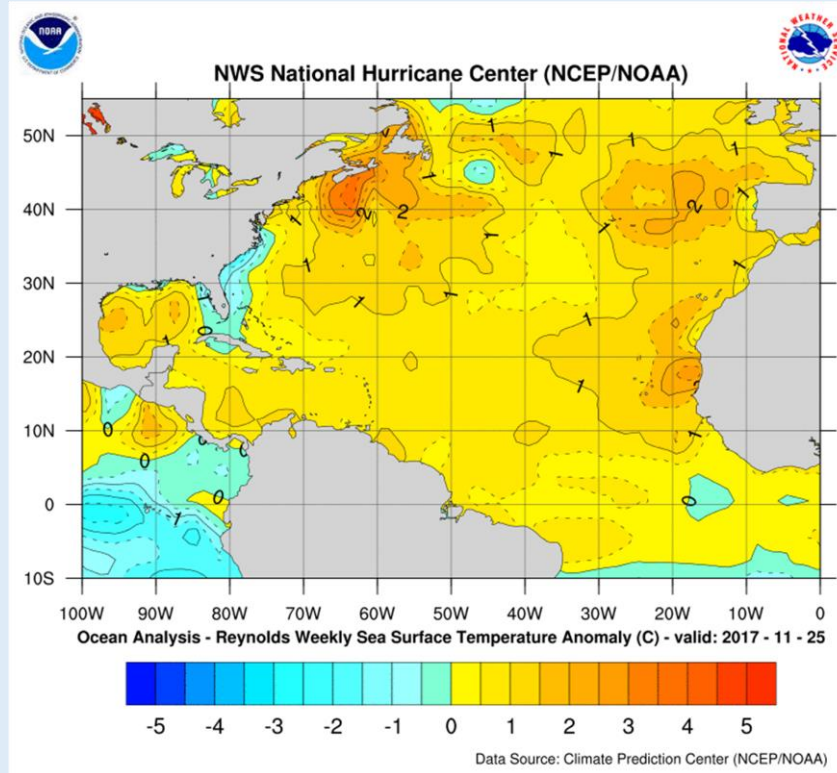
Figure 6: ENSO Season, 1990-2017



Source: Twelve Capital, ILS Analytics. US National Oceanic and Atmospheric Administration (NOAA).

Sea Surface Temperatures: Atlantic and Pacific sea surface temperatures (SST) are warmer than average at this time, as can be seen in figure 7. Anomalies in SST occur for many reasons, including El Niño, the weather, ocean currents and climate change, but can lead to more severe hurricanes. There is a positive correlation between higher SST and storm frequency/intensity.

Figure 7: Atlantic Sea Surface Temperatures



Source: NWS National Hurricane Center (NCEP/NOAA).

Climate Change: Whilst 2017 was certainly an extraordinary year in terms of hurricane and landfall activity, previous hurricane seasons have also been very active, as described above, and investors should avoid using 2017 as a basis for extrapolation into the future in our view. Interestingly, after 2005 not a single major hurricane made landfall in the US until this year. If climate change were indeed responsible for sustained increases in hurricane activity, this would immediately contradict that theory. The “clustering” of hurricane activity is also not the result of climate change, which is a long-term phenomenon, but is instead a function of many short-term atmospheric and oceanic factors. The North Atlantic Oscillation, concentration of Sahara dust in the air and the ocean surface temperature are contributing factors that are highly volatile year on year. These are the principle factors influencing cyclone formation. Climate change certainly affects the sea surface temperature, but in a rather slow and gradual way. The impact on short-term ocean currents is limited to non-existent.

Research generally suggests that climate change, mainly through the transmission mechanism of increased sea surface temperatures, may – on a multi-decade horizon – result in increased severity of storm systems, but not in increased frequency or probability of cyclone formation. Excellent quality data on Atlantic hurricanes has been available since the 1850s and, thus far, there is no statistically significant trend visible in severity nor frequency.

Warm sea surface temperatures are well reflected in models and Twelve Capital runs sensitivity analyses on ILS instruments that cover tropical cyclone risk. Generally, when running this sensitivity analysis, the increase in expected loss for an investment is limited and does not suggest any “structural breaks” in terms of cyclone behaviour and subsequent insured losses.

As climate change is still a rather slow process, taking many years to make meaningful differences to the risks around ILS transactions in our view, it should be a lesser focus for the market at this time, as the maturity of cat bonds and private ILS contracts tend to be for much shorter periods of time. Private ILS transactions typically expire and renew every calendar year, so any increase in risk as a result of changing climatological conditions would be reflected through higher reinsurance premiums each year, and hence investors would be compensated for this.

ILS – market structure and instrument characteristics

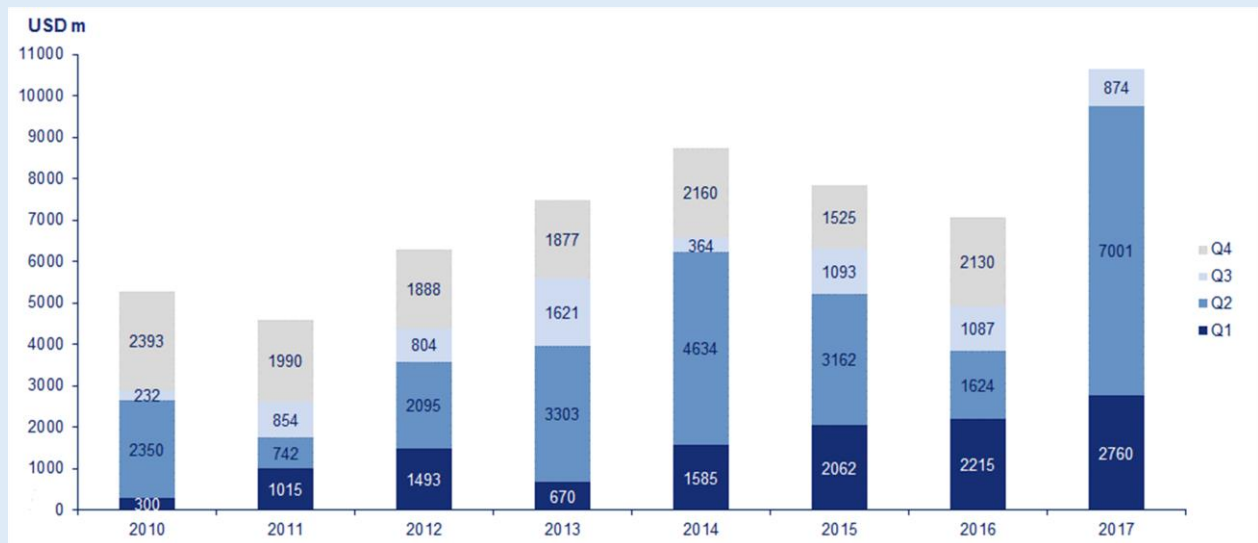
The ILS market is growing in size and improving in structure

The cat bond market has grown substantially in size during 2017. After record issuance activity during the first half of the year, when more than USD 10bn of new cat bonds were issued, the cat bond market has now grown to a record size of around USD 29bn. The new bonds brought to market in 2017 included a World Bank and WHO-backed instrument covering global pandemic risks, such as influenza, filo- and corona- viruses. This note was issued directly by the IBRD without any intermediating SPV structure, and the successful placing of the transaction highlights the openness of ILS investors to look at new perils as well as new structures brought to the space.

At USD 50-60bn in size, the private ILS market is roughly twice as large as the more liquid cat bond space, and compares to a total ILS market size of approximately USD 80-90bn. Whilst the cat bond market focuses on natural catastrophe risks that occur with low frequency but high severity, a much wider variety of perils is reinsured by the private ILS market. These perils include man-made risks such as fire, marine, terrorism, aviation or contingency transactions.

Twelve Capital expects strong growth to continue in the alternative reinsurance space, through capital markets based solutions such as cat bonds and private ILS transactions. Recent catastrophe losses have eroded capital in the traditional reinsurance market, resulting in a scarcity of available reinsurance protection in our view. Consequently, many ceding companies are looking at the possibility of substantial premium increases in their standard reinsurance coverage programs and, in order to diversify their reliance on those programs and their providers, cedants are increasingly looking at cat bonds and private ILS contracts as viable alternatives.

Figure 8: Cat Bond new issuance levels since 2010



Source: Twelve Capital, Aon Benfield Securities, Inc., Artemis (Q3 2017 Catastrophe Bond & ILS Market Report).

The impact of multiple events on aggregate bond structures

The various natural catastrophe events that have occurred during the second half of 2017 again underline how important structural differences within ILS instruments are and how those can result in very distinctive types of behaviour during times of stress. This behaviour became visible after Hurricanes Harvey, Irma and Maria struck the US and various Caribbean islands during August and September of this year. All of those events were large natural catastrophes causing loss of life, substantial economic damage and insured industry losses. However, these events were not large enough to impact more than a few cat bonds on an individual occurrence basis.

Nonetheless, secondary market prices of many bonds dropped sharply following these events. This behaviour mainly occurred in cat bonds featuring aggregate trigger structures and reflected the fact that each individual event, no matter its size, eroded some of the attachment of those bonds and consequently increased the risk of future events causing losses to the actual insured layer, as the “buffer” shielding the cat bond layer became smaller and smaller.

An aggregate cat bond or private ILS contract accumulates losses over time during a pre-defined risk period, which is typically annual. If the accumulated losses during such a risk period exceed the attachment amount, the bond's insured layer starts taking losses resulting in a partial or complete loss of principal. For most bonds featuring aggregate trigger structures, Hurricanes Harvey, Irma and Maria individually and combined were not sufficient to exceed the respective attachment points. However, these storms have reduced the amount of attachment available as a buffer for potential future events. As the attachment erodes, the probability of losses to the insured layer increases and hence the risk profile of the entire bond rises. That increase in risk is reflected by investors through a drop in secondary market prices, resulting in higher spreads.

Due to the reset feature of these instruments, this phenomenon is likely to be of a temporary nature, as long as the insured layer itself does not take any direct losses before its reset date. In that case, the attachment amount is fully restored and the bond reverts to its initial level of riskiness. This would then typically be reflected in higher secondary market valuations.

The claims handling process after a major hurricane

One of the reasons why cat bond valuations remain volatile for quite some time following an event centres around the uncertainty of the ultimate loss development. This is particularly true for cat bonds structured with indemnity triggers, as the uncertainty around industry-wide losses is typically resolved more quickly than that of individual insurance companies. For illustrative purposes, a hypothetical example is outlined below.

The ultimate loss development after an event can take between several weeks to many months to resolve, depending on the nature of the event. During that time, insurance companies will update their reserves, which are established after an event, based on actual claims development. Ultimately, this can result in higher or lower losses compared to the initial reserves.

The following hypothetical example is intended to serve as an educational illustration on the claims development process post a Floridian hurricane.

Time	Description	External communication with ILS/cat bond investors
Day -2	A category 4 hurricane approaches the coast of the US and is likely to hit Southern Florida. The government issues evacuation orders and thousands of people leave their homes for safety.	
Day 0	The hurricane hits Southern Florida as a category 3 hurricane. Some buildings are destroyed whilst others suffer wind and flood-related damage. There are widespread power outages and streets are blocked due to debris and severe flooding. All flights are cancelled.	
Day 5 - 10	The streets are mostly passable and electricity is restored to the majority of areas. Families return to their homes and take a first look at the damage caused to their properties. Policyholders file an initial claim with their insurance company, potentially providing pictures of the damage.	Event notice (not always provided)
Day 10 - 20	Based on the information provided by policyholders, the claims team at each insurance company prepare a first estimate on potential losses, which is then reflected in the company's accounting through a reserve provision. Depending on that initial damage estimate, insurance companies could decide to bring in a claims adjuster to survey the damage at a particular site. Often minor damage (e.g. below USD 2'000) might be paid without an onsite assessment, due to the general lack of a sufficient number of claims adjusters following major catastrophes. For larger amounts of damage, such as the loss of an entire roof, bringing in a claims adjuster might take time, as the number	Initial loss estimate (not always provided)

	of people in the profession is limited and demand for their services after a major event surges.	
Day 20 - 40	Claims adjustors arrive at each site and survey the damage caused. Insurance companies then update their reserved amounts. A decision is taken around whether buildings can be repaired or whether any structural damage caused is too great. Contractors are then mandated to carry out necessary works, although high levels of demand could mean that they are not available right away. There could also be a shortage of certain building materials required.	Updated loss estimate provided to the reinsurance market.
Day 30 - 90	Buildings are repaired and policyholders or insurance companies receive the final bill from contractors.	
Day 90 - 120	Invoices are settled either through the insurance company directly or by the policyholder, who would then receive payment from their insurance company. The insurer's reserves are transformed into actual losses and cases are closed. Policyholders might decide to litigate in the event that there is a disagreement with their insurance company around the actual level of pay-outs.	A preliminary ultimate net loss figure is communicated. If a cat bond is affected, an event loss notification report would be filled shortly thereafter.

ILS market outlook

Impact assessment

The events of the 2017 hurricane season, as well as two earthquakes in Mexico and a number of thunderstorms in the US during Q2, have had a profound impact on reinsurance markets as insured industry losses could potentially exceed USD 100bn for the year. Given the magnitude of losses, cat bonds and other capital markets-based insurance instruments have been affected through principal write-downs and increased levels of mark-to-market volatility, as previously discussed.

The Swiss Re Cat Bond Index, which tracks the development of secondary cat bond market prices, lost around 18% of its value when Hurricane Irma approached Miami in September. As the hurricane's track shifted to the West, the index quickly recovered around half of these losses in the days that followed.

Since that time, some cat bonds have fully recovered, a number have recovered the majority of their losses, although still trade wider than pre-Irma levels, and several cat bonds are still trading at depressed levels. The reason for this volatility in the secondary market is generally a function of:

- Actual principal write-downs, which have either happened already or where there is a strong likelihood of this happening in due course;
- Uncertainty regarding the development of ultimate losses;
- Uncertainty concerning cat bond extension risk or locked collateral in private ILS transactions;
- Increased riskiness of aggregate structures which have lost some of their attachment;
- An increase in overall spreads, i.e. a market-wide repricing;
- Shifts in valuation policies, such as switching from "best bid" to "average bid" in the event that price dispersion exceeds a certain threshold.

Having said this, some of the reasons stated above are clearly temporary. As time passes, the uncertainty with regard to the ultimate loss reduces and it becomes clear which positions will suffer principal write-downs. Also, the majority of aggregate bonds are expected to revert back to their initial levels of riskiness after each reset date and, consequently, market prices should recover. The same is true for accounting and valuation differences, which tend to converge over time.

In our view, the repricing aspect mentioned above is one of the main factors that might persist for some time and which should offer investors an attractive entry point into the asset class.

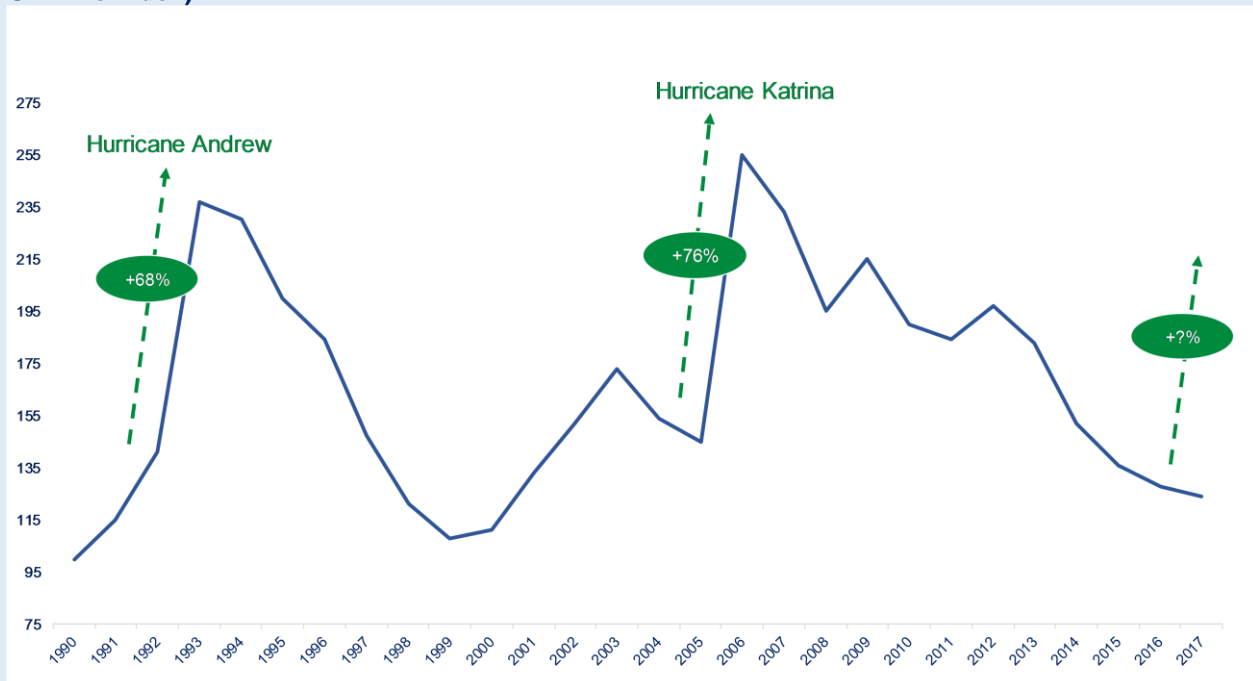
Repricing and investment opportunities

A number of cat bonds and private ILS transactions which have a certain likelihood of suffering losses from recent events are unlikely to repay their principal at the scheduled maturity date in our view. Instead, cat bonds are likely to be extended and the collateral of private ILS contracts will potentially be held in trust until the final outcome of losses is known. This can take anywhere from several weeks to up to three years, with such capital no longer available for writing new protection during that period.

In general, locked collateral continues to earn money market interest rates with a small spread on top, typically 10bps. This locked capital is not available for reinvestment into any new issues or for the renewal of bilateral reinsurance contracts and, as such, has a negative impact on the overall IRR of any private ILS portfolio as substantial amounts of capital may not be available and could sit idle earning only the risk-free rate of return.

Although this situation affects the entire ILS market, the shorter maturity profile of private ILS contracts means that this segment is more exposed than the cat bond market to such a phenomenon. The amount of trapped collateral in the private ILS market results in a scarcity of capital available for the January 2018 renewals season, which subsequently translates into higher, sometimes substantially so, insurance premiums. This can be witnessed from similar events in the past, as illustrated in figure 9.

Figure 9: Major storms and their effect on pricing (Guy Carpenter US Property Catastrophe Rate-On-Line Index)



Source: Twelve Capital, Artemis. As at 1 November 2017.

Twelve Capital believes that several opportunities in the ILS market have arisen over the past few months, not only in terms of premium increases but also in terms of new portfolio management methodologies as well. Although premium increases form a substantial part of the improved opportunity set, the situation is somewhat more complex and requires certain pre-conditions on the part of any investment manager, as detailed below.

Opportunity	New opportunity set
Higher reinsurance premiums	<ul style="list-style-type: none"> - Based on Twelve Capital's current assessment, the cat bond market is likely to see premium increases of between 5-15% and the private ILS market is likely to see premium increases of between 10-30%, depending on the specific line of business. - Some niche areas of the private ILS market could see premium increases beyond the range noted above.

	<ul style="list-style-type: none"> - An optimal portfolio aiming to monetise this new opportunity set should have the flexibility to allocate capital between cat bonds and private ILS transactions in our view, in order to capture the optimal risk-return profile. - Twelve Capital's Dodeka programme allows the securitisation of private ILS contracts for cat bond funds, so that these more liquid vehicles can access part of the reinsurance market, as long as certain criteria are met.
<p>Portfolio and risk management</p>	<ul style="list-style-type: none"> - Recent events have underlined the importance of a portfolio management approach that reflects all the risks of an underlying insurance portfolio. - Portfolio management approaches focusing purely on geographic peril buckets fail to fully assess the risk of events and largely ignore diversification benefits within those geographic buckets in our view. - Twelve Capital strongly believes that cat bond and private ILS strategies should be managed with the highest possible levels of look-through into the underlying insurance contracts, to continuously optimise risk-return profiles. - Through optimising a portfolio along the entire P&L probability distribution, including the tails, portfolio managers can take advantage of the benefits of diversification between different securities, which could be overlooked in the risk bucketing approach. The assessment of marginal risk and marginal return contribution of each security allows for the construction of better and more suitable portfolios in our view.

Twelve Capital – our view

Despite the number of events impacting the reinsurance and ILS markets during 2017, the outlook for the asset class on both a short- and medium-term view is, in our opinion, a particularly positive one.

During a time of intense pressure, the ILS market has proven its structural robustness and investors have remained committed to the asset class, with a number increasing their allocations to the space over the past few weeks.

For Twelve Capital in particular, the changing opportunity set in this market, driven by spread widening and new portfolio management techniques, remain influential factors in the development of new investment strategies at the firm, as well as in the continued optimisation of existing mandates and portfolios.

Combined, in our view the outlook for the ILS asset class is stronger than it has been for many years, providing both an attractive entry point to allocate into the space and an opportunity for existing investors to increase their exposures to the market over the mid- to long-term.

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