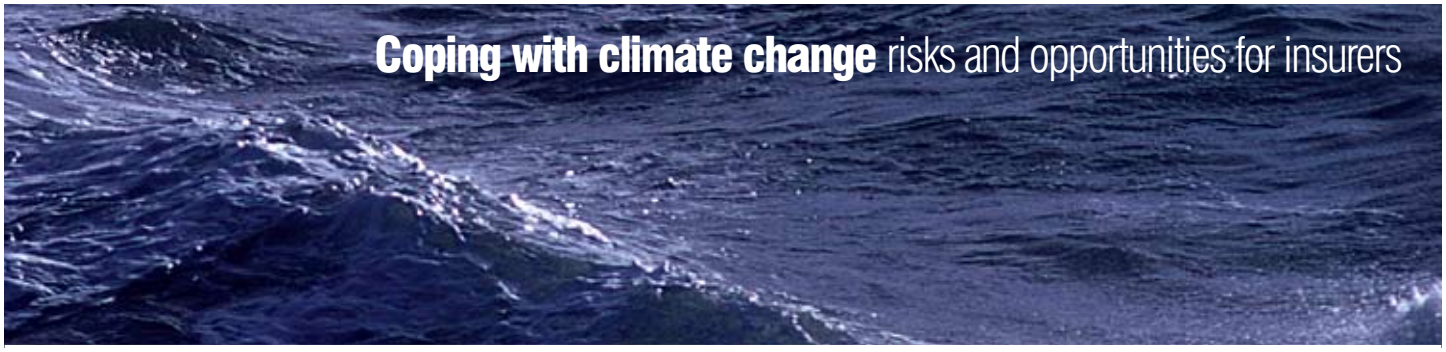

Chapter 6

Capital Markets and climate change

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6.1 Introduction

This section details the two major areas in which the capital markets engage in weather related risks. The first is the Insurance Linked Securities (ILS) market, which as its name suggests has a close link with insurance businesses, and the second is the weather derivatives market, which is utilised by a wider range of businesses. A current distinction between the two areas is that Insurance Linked Securities are 'over the counter' meaning buyer and seller in direct negotiations, whereas weather derivatives can be exchange traded.

6.2 Insurance Linked Securities

Since 1996 the capital markets in the form of fixed interest (bond) investors have taken increasing participations in what were once considered solely insurance or reinsurance risks.

Whilst this market is not restricted to weather related risks, indeed the preferred name for the bonds are Insurance Linked Securities, it is the extreme event which gives its name to a substantial part of this market, the so called Cat (Catastrophe) Bond.

This section details the current size and scope of this market and its projected direction, relates it to the overall bond market, and then provides the general theory and operation of a typical Insurance Linked Security, the types of bond available, and outlines some considerations in their use and applicability for extreme weather events.

The Cat Bond Market

The Market

The Cat Bond Market since its inception in 1996 has grown markedly from a very few deals in its early years to a steady turnover today. The traditional insurance measures of size (premium income related) are not typically applied in the Cat Bond Market, where a bond orientated measure relating to funds extended or at risk is used.

Pure weather related bonds tend to be limited to the peak weather events currently exposed of Hurricane (US Wind), Typhoon (Japan Wind), or North Atlantic Storm (Euro Wind). Other cat bonds are Earthquake related, and some are Multi Peril tending to be a mixture of peak weather and peak earthquake risks. More recent bond issues have extended into areas of Credit, Motor and Industrial Accident, and there is an active ILS market for Life insurance related risks. Here we will concentrate only on the weather related market including Multi Peril bonds with a weather element.

Figure 1: Weather Related Insurance Linked Securities

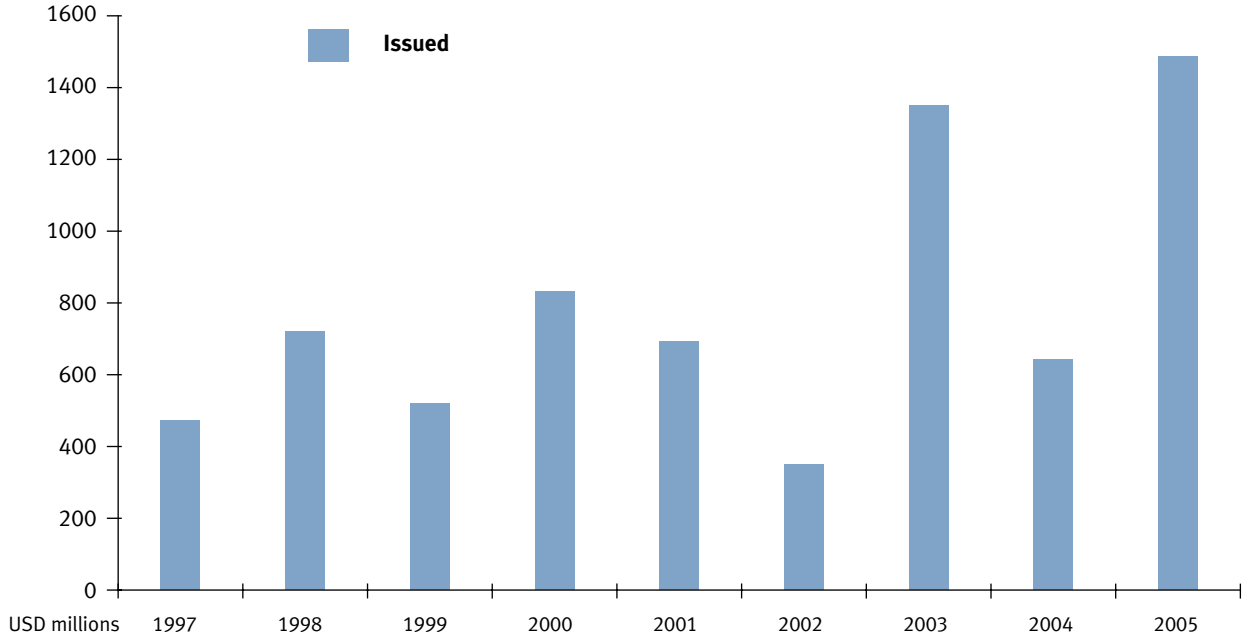


Figure 1 shows a general upward trend in terms of value at risk issued by year. However, the structure behind a cat bond is multi year and therefore the actual value at risk accumulates year by year until earlier year bonds reach maturity (or bonds themselves are triggered).

Using this measure the weather related cat bond market takes on a more significant profile against the traditional insurance and reinsurance markets and could account for between 5% and 7% of the total values at risk in relation to a peak weather event.

The bond market as a whole

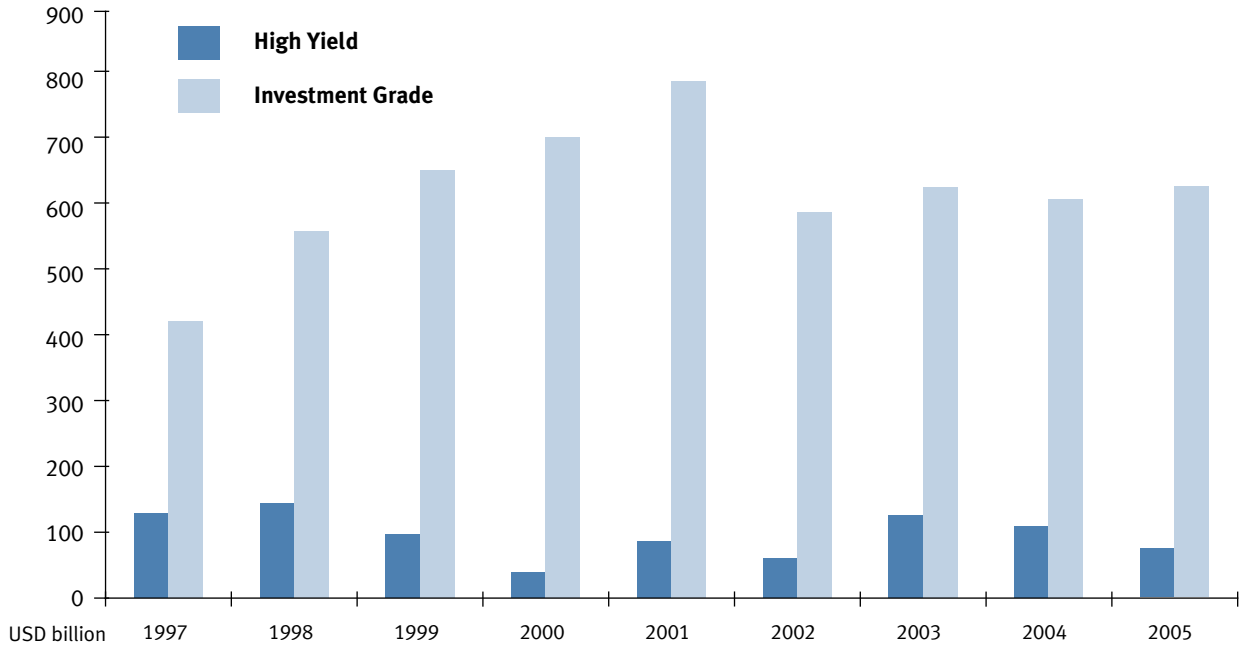
The bond market itself is enormous, and is the part of the Capital Market where funds are extended over a period of time in return for an interest payment.

The bond market is classified into various sub markets, an abbreviated classification being Government Debt, Corporate Debt and Asset or Mortgage Backed Securities. Even though ILS can be considered as part of the Asset Backed Securities market by virtue of the Special Purpose Vehicle (Entity) construction, the debt itself is issued by a corporation. It is against this corporate market that comparisons in terms of relative size are made.

It is worth mentioning that rating agencies have a significant influence on bond price and indeed potential investors, in that the risk of default on the loan is the main driver of pricing and some investors are restricted from investments in low rated debt (Pension Funds).

European or United States Government Backed Securities where default risk is virtually nil have a zero rating considered to be above AAA (S&P), and Corporate Bonds from certain major global corporations would commonly carry AA+. As a result a distinction can be made between low risk of default bonds (BBB and above) being known as 'Investment Grade' and anything below being termed 'High Yield' or less flatteringly 'Junk'. The attraction for investors is that the price/yield is significantly higher with a higher potential risk of default but the actual investors are lower in number as many will be restricted either by policy or legality from investments in anything other than Investment Grade debt.

Figure 2: Corporate Bond Issuance



In summary, if ILS are considered as part of the Corporate Bond High Yield Market, the market is considerably smaller than a commonly expressed view that the whole Capital Market is opened up to investment in ILS. In fact the total market available is somewhat volatile suffering expansion and contraction of capacity in a similar way to insurance and reinsurance markets (although the driver here is increasing loan default often associated with recessionary markers). In size the market itself varies between USD 40bn and USD 140bn, which at least bears a scale comparison with the overall reinsurance market capacity.

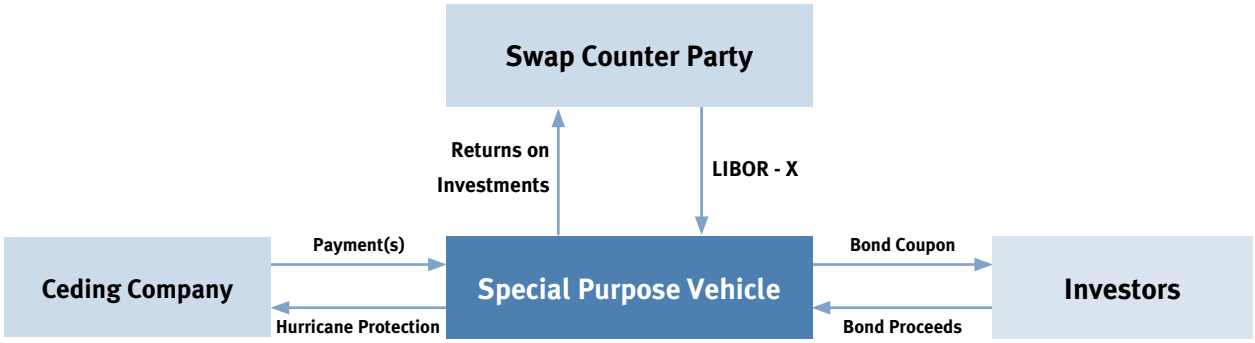
In 2005 the issued ILS for Weather Related Securities approached USD 1.5bn against a total 'High Yield' Issuance of USD 75bn indicating a 2% market share.

ILS – the theory

The theory behind cat bonds follows the principles behind securitisations, which have been common in the fixed interest investment market for many years. As such the insurance element can be considered as just another form of asset, which is pooled and transferred to an investor who bears the default risk in return for a regular interest payment (coupon). This interest rate would be greater than that available if invested in most other fixed interest investments by virtue of the greater probability of default and hence loss of initial investment.

The attraction from the investment community is that the likelihood of default on a cat bond (i.e. an insurance event) is not closely related with any other default (economic downturn) of fixed interest investments (and is therefore non correlated), and hence gives diversification of the investment portfolio whilst attracting good rates of return.

Figure 3: ILS Structure



A typical ILS structure would involve four parties, the ceding company (typically a reinsurer, the 'sponsor'), the investors (large institutional buyers, who would have an ILS as one of many investments), a special purpose vehicle (the issuer, typically Bermuda or Cayman Island based), and a swap counter party.

The Special Purpose Vehicle is topical as its purpose is purely to assume debt and comply with regulatory requirements of the relevant trading exchange. (Rule 144A.)

The issuer sells securities to the investors, so that the issuer receives funds from the investor (bond proceeds), which are then invested by the issuer in a trust fund. The returns on this investment are then converted by the swap counter party to a LIBOR (or equivalent) based rate.

Simultaneously the Special Purpose Vehicle enters into a contract with the ceding company for the same period and value as the bond, to provide protection against the 'event trigger' (in this case hurricane). In return the special purpose vehicle receives regular payments from the ceding company for the bond period.

In terms of payments, the bond coupon payable to the investors would be a LIBOR (or equivalent) based rate + additional basis points (interest) to cover the risk of default.

The bond proceeds themselves are already earning a return by virtue of their investment in the trust fund (this may be less than LIBOR) so the payment due from the ceding company for its protection is the required return from the investors (coupon rate) less the return from the swap counter party.

In the event that the contract between ceding company and special purpose vehicle is triggered, the trust funds are transferred to the ceding company (constituting the hurricane protection), and the bond itself is held in default, whereby the investors lose their original investment and any further coupon payments which may be due.

There are many permutations on this standard operation particularly as to whether all of the proceeds are transferred on event trigger and whether payments continue after that date or not, but in general terms this structure accommodates the ILS operation.

The period of the bond is commonly between three and five years, during which period the coupon rate would be fixed. It therefore brings stability to costs during this period. At the end of this period if no trigger event has occurred the funds are returned to the investor.

The bond proceeds (the investment) are contributed at the beginning of the period and subsequently held in trust. Therefore the likelihood of non availability of funds in the event of a trigger is extremely low.

These form the basis of the benefits over the traditional reinsurance market in that for peak risks cat bonds bring a stable cost base over the medium term and certainty around payment recovery.

Products available

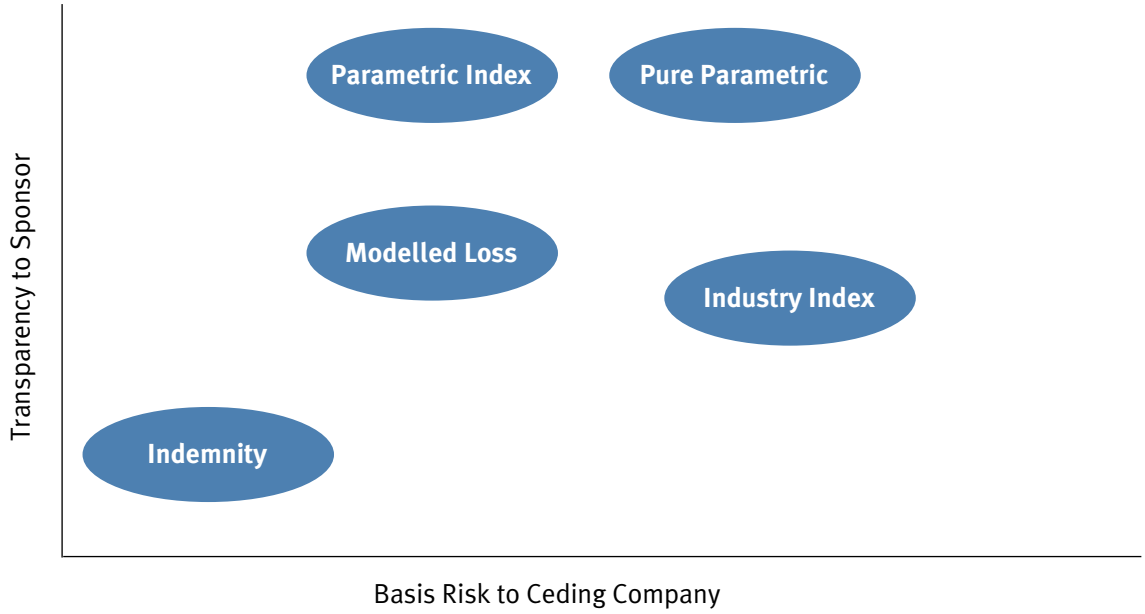
There are five main types of cat bond distinguished by the event trigger.

These are:

- Indemnity Trigger
- Industry Index Trigger
- Modelled Loss Trigger
- Pure Parametric Trigger
- Parametric Index Trigger

There is a trade off between the transparency to the investor (knowledge as to what and when a trigger event occurs) and basis risk to the sponsor (ceding company) where basis risk is the potential mismatch between the ceding company's loss and the recovery from the cat bond.

Figure 4: Transparency and basis risk



Indemnity trigger

Indemnity trigger deals operate in a very similar way to a standard excess of loss reinsurance. A predetermined trigger point is established as the attachment point and when the ceding company's own losses exceed this point all further losses are recoverable up to the limit of the bond.

Generally these tend to be more expensive than other trigger types as the investor is assuming not only the likelihood of the event occurring, but also the operational risk of the ceding company's underwriting and claims functions.

However, from the ceding company's perspective the basis risk is low as the actual losses it incurs are those that are recoverable.

Indemnity index trigger

These operate in a similar way to an Industry Loss Warranty policy, although here a ceding company would recover a percentage of total industry losses beyond a pre-determined attachment point and up to the bond limit.

An Industry Index trigger is more transparent to investors than an indemnity trigger in that an independent party is determining the size of the industry loss, and the overall industry competence in underwriting and claims is being assumed.

The ceding company need not disclose proprietary information as it is its relationship to the industry as a whole, which is being protected by way of set percentage. This exposes the ceding company to basis risk in that if its pattern of losses differs markedly from the industry as a whole at the pre-determined industry trigger point, it will remain exposed to its own losses with no prospect of bond recovery, or alternatively benefit from a windfall recovery where its underlying losses are less than the market average.

In both the Indemnity and Industry Index trigger there may be some time between actual event and determination as to coverage due to the time taken for the loss itself to fully develop.

Modelled loss trigger

In a modelled loss trigger, after a catastrophe occurs the physical parameters of the catastrophe are entered into a third party model to project the losses to the ceding company's portfolio at that time.

Any bond payout is established on the modelled estimate, and not the actual losses which develop.

This clearly exposes the ceding company to basis risk, and puts considerable strain on the modelled output.

Investors also struggle with the transparency of the modelled loss as they cannot assess the validity of the third party model against the particular portfolio.

Parametric triggers

Parametric triggers are very transparent to investors as they are based on purely physical characteristics of the event.

Most operate on a 'grid' system being a relationship between the actual location of the loss, the severity of the event (wind speed) and the percentage of the bond available for recovery.

So a parametric trigger could be developed for Tampa, Florida, with a wind speed of 120 mph, which would trigger 100% of the bond value. For a graduated reduction in wind speed and distance from Tampa, there would be pre-agreed percentage reductions in the amount of bond triggered. Perhaps a radius of 200 miles and a wind speed of 70 mph representing a 0% recovery.

From the investors' perspective this is far more transparent, and cuts the development period as once the parameters are established it is the application of the formula which determines any bond recovery.

From the ceding company's perspective, considerable basis risk has now been assumed in that if its portfolio varies in geographic location from the cat bond, or if a relatively minor event triggers a disproportionately large loss it could find itself unprotected.

Parametric index trigger

A parametric index trigger is a refinement of the parametric trigger and tries to get closer to the actual ceding company's exposed book of business. It does this by creating a much more detailed 'grid', and applying various weights within the grid which represent the ceding company's exposure in that area.

Again it is a formula based on an original physical event, and hence once the wind speed and location is entered into the formula the resultant 'index' will determine the bond payout.

This is completely transparent in the eyes of the investment community, but again does not remove basis risk on the part of the ceding company, although it is less than the pure parametric trigger.

Summary

Early cat bonds tended to focus on the indemnity approach being somewhat familiar to an existing reinsurance framework, where over time ceding companies have increasingly turned to industry index and parametric triggers.

It is the view of the investors in particular that Parametric Index triggers will become prevalent although there is likely to be a significant co-existence of different triggers and structures to accommodate different ceding companies' needs.

Considerations for the Insurance/Reinsurance Industry

Availability and pricing

To date most weather related cat bonds have concentrated on peak exposures, US Wind, Japan Typhoon and North Atlantic Storm. These are the risks, which could cause the largest losses in absolute terms and hence have the largest capital requirements from those seeking to protect them. They have tended to be purchased by reinsurers or very large insurers who have been able to diversify the non peak risks amongst their own large portfolios leaving just the peak risks with a high capital requirement.

The amount of capital that a well diversified reinsurer must hold for non peak risks is lower than for peak risks and this translates to a lower pricing structure. So for non peak risks the capital requirement and the attraction of pricing has not existed in the cat bond market in relation to the traditional reinsurance market.

However, for a smaller, less diversified insurer, the distinction the industry makes between peak and non peak exposures does not apply and therefore an industry 'non peak' exposure could be that insurer's very peak exposure. Hence some insurers with very specific exposures are seeing cat bonds, which offer a fixed period price with little counterparty risk, as an attractive alternative to the traditional reinsurance market.

There has been increasing interest particularly from the newer insurance markets with well defined specific 'main' weather related exposures to at least explore the cat bond solution for their particular requirements. Certain Indian weather related crop insurances are an example.

In terms of Cat Bond pricing in comparison to other Corporate Bonds there are indications from research that the Cat Bond itself is priced more in line with existing insurance considerations than with any likelihood of actual bond default (Christofides).

Taking a cross section of the Corporate Bond market and comparing High Yield bonds with the same rating over time, Christofides found that the actual bond default levels compared to the expected bond default levels (i.e. yield) were broadly in line, and that the investors were just ahead on the returns side of the equation. However, they had suffered some very high default years (lost money) and also had some very good years, indicating the overall volatility of such a market.

What was more surprising is that for the same rating level an ILS would be priced at a multiple (2 to 3 times) of a 'normal' corporate bond, and yet the default experience over a comparable period is significantly worse for the normal bond. Bearing in mind the earlier comment that over the period the investors in normal corporate bonds had been slightly ahead on returns it suggests that the pricing on ILS issued debt is being driven by factors other than either actual or comparative default experience.

Two suggestions as to why this may be so stand out. The first is that there is a significant sensitivity in the ILS market to the headline event, and whilst the reality is that very few of these weather events convert into actual ILS defaults the underlying effect is that these events are taking place and the investors are very aware of them. The second is that ILS pricing is possibly following a more reinsurance market based modelling and developing a similar pricing structure, which is ignoring the actual default levels experienced and hence creating a substantial price differential.

Christofides notes that neither of these actually help the market nor the issuers. On the one hand the market is not bringing its capacity at a default driven price and as such is restricting the availability of the product, on the other the issuers appear to be overcharged and as such are unlikely to seek further product. Much of the discussion around ILS has been its comparative pricing to the existing reinsurance market, and not its comparative price yield to the corporate bond market where ILS are looking expensive.

Cat bond operation

There are three key considerations regarding the operation of a cat bond that make it quite different from a traditional reinsurance contract.

Firstly, the assumption of basis risk (under most triggers) by the ceding company. This potentially means that the losses incurred by the ceding company are not recovered from the bond, and the bond coupon (interest) remains payable for the bond term.

Secondly, the bond period would exceed the general insurance periods assumed by a ceding company, so that within the bond period exposures to the bond would vary. As a result of this the investors take a great deal of interest in the underlying exposures and often require detailed reporting of a type and level not commonly required in the traditional reinsurance arena (although attitudes here are changing).

Thirdly, whilst the ILS structure seeks to shield the ceding company directly from the investors by way of a Special Purpose Vehicle, it is implicit in the arrangement that the ceding company is assuming a debt on which interest is payable, and as such the ceding company is altering its capital structure. Whilst it can be argued that reinsurance itself is a form of capital, it is not formalised as such. In a very simple case, where there is no loss the earnings per share would be decreased as the 'profit' is now impaired to the extent that there is an existing interest payment due to the assumption of debt. In the case where there is a loss, the debt relief, effectively increases the earnings per share, as the maintenance of the debt has now been removed.

Conclusion

The ILS market continues to develop and provides a meaningful if specialised solution to certain peak weather exposures.

There are major considerations from a purchasing viewpoint as to whether such a solution is appropriate, but the ILS market does offer a clear alternative to a traditional reinsurance route.

In the event that weather events become more severe and have a wider geographic spread (beyond current capital intensive peak risks), there is significant potential in the ILS market to assume such risks in direct competition to a standard reinsurance contract.

6.3 Weather derivatives

Introduction

Weather derivatives have also developed over a similar period to the ILS market, but instead of attempting to accommodate the peak exposures for a specialised market (low frequency, high risk) they deal with a wider market for the higher frequency but lower risk exposures. Whilst ILS are a form of bond traded 'over the counter' between buyer and seller, weather derivatives are options which may be over the counter but are also exchange traded, giving the benefit of an active trading environment.

This section considers who participates in such weather derivatives, the types of weather derivatives and the markets in which they are available, describes the operation of a weather futures 'hedge', and makes some observations about relevance and use in the wider context of changing climate.

The participants and the market

There are a wide range of companies whose budgets or profits may be adversely affected by unseasonal weather. These 'hedgers' would include energy companies, construction firms, agricultural businesses, a large part of the leisure and entertainment sector and potentially Government and Government Agencies. The investors or speculators are mainly made up of hedge funds with the Lead Market Maker being Wolverine Trading.

In order to bring the two sides together in a market 'weather risk' which has no underlying monetary value (unlike company shares, or currency) are converted to standard indices, and the deviation from seasonal averages for particular cities creates a tradeable commodity. By necessity these indices are quite specific and currently limited to just temperature, snowfall and frost. The locations for the measurement are specific cities mainly in the US, but most major European cities are represented for temperature, Boston and New York for snowfall and Amsterdam for frost.

This leads to a similar comment on 'basis risk' as made under the ILS section in that the purchaser may have suffered a different weather experience than the identified index city and could either reap a windfall reward, or have suffered a revenue loss but have no return from the contract.

The market itself has shown tremendous growth since 2003 in particular, with a notional traded volume increasing from USD 2.2bn to USD 22bn over the period with 2005 seeing over 600,000 contracts traded.

The types of weather derivatives

There are currently three traded weather indices, temperature, snowfall and frost.

Temperature was the first traded index as a result of energy related trades and is based on temperatures either exceeding 65 degrees Fahrenheit (18 degrees Celsius for Europe) over an averaged period for summer (May to October) weather (the Cooling Degree Day Index) or not exceeding the same temperature for winter (November to April) weather resulting in a Heating Degree Day Index. Although appearing arbitrary the 18 degree 'trigger' does correspond to when energy companies experience an increase in demand due to either heating or cooling systems being switched on.

To establish an HDD contract value, daily index values are calculated by taking the average daily temperature and subtracting it from the trigger value. So in Fahrenheit if the average daily temperature were 40, the days index value would be 65 – 40 = 25. If this equation results in a negative value zero is applied as above 65 it is assumed that heating is not required. For the monthly index all these values are simply summed. So if for ten days during November the average daily temperature was 40, and for all other days it was 65, we would have 10 days times 25, or 250. Each index point has a value of USD 20, and hence the November HDD weather contract would settle at USD 5,000.

There are some currency and measurement differences between a US temperature contract and a European one, but which do not affect the overall theory of their operation.

The purchaser would determine how many contracts required based on potential revenue loss and buy appropriately.

The cities available for temperature indexing are in the US : Atlanta, Baltimore, Boston, Chicago, Cincinnati, Dallas, Des Moines, Detroit, Kansas City, Las Vegas, Minneapolis, New York, Philadelphia, Portland, Sacramento, Salt Lake City and Tucson.

In Europe: Amsterdam, Barcelona, Berlin, Essen, London, Madrid, Paris, Rome and Stockholm.

In Japan, Osaka and Tokyo.

Snowfall is a far newer index and is currently only available for two US cities being Boston and New York where they can be traded monthly between October and April.

The index measure is inches of snow summed for the relevant month with a unit being USD 200. This leads to quite an active put and call (sell and buy) market with between 50,000 and 100,000 contracts being traded monthly.

Frost is only available indexed for Amsterdam, and are based on the number of days that frost is recorded on weekdays between November and March.

Operation of a weather futures contract

The range of organisations using weather derivatives to potentially offset revenue impacts due to unexpected weather patterns is increasing, so in this section two businesses which may benefit are given.

Whilst such weather events may not make headlines, frequent unexpected changes in weather can have a serious effect on revenue and this is where a weather derivative seeks to manage such risks.

It is worth mentioning that such derivatives are not associated with any loss of revenue occurring and therefore some businesses and traders can use this market purely to increase revenue or protect revenue streams. This is particularly noticeable with trades where an over the counter weather derivative has been sold and the seller offsets such a contract with a hedge on an exchange trade. This gets closer to common risk management practices on share trading where the purchase of shares at a given price is offset by an option to sell if the price falls. Hence if the share goes up the trade 'wins', if it falls the option is executed and the fall in value is offset by a secured sale at the higher share price, the only 'loss' is the option price.

Example 1

A fertilizer manufacturer knows that a cool spring will prevent crops being sown early and hence demand for its product in the 'spring sale' will be depressed.

The futures hedge is to sell (go short) Cooling Degree Day contracts for the spring period. Let's imagine they sell at CDD 400, which is the average for that area.

If the weather is cooler than normal and only reaches a level of 300, they can buy back their CDD contracts at 300, making a trade profit of 100 index points times USD 20 or USD 2,000 per contract. The number of contracts sold should equate to the expected loss of revenue and hence offset the fall in sales.

Example 2

A ski resort relies on cold winters particularly for January and February. To protect against warmer weather in these periods the resort could short (sell) Heating Degree Day contracts at a level above the normal for the area (or reference city).

A warm winter will result in a low HDD index and the resort would seek to buy back its contracts at a lower price and hence offset any loss in business.

It is clear from both of the above examples that there is considerable variation in both the likely loss of revenue and the potential return from a futures contract. This is a concept foreign to most insurance contracts as indemnity is a fundamental concept in their operation. Here the fertilizer manufacturer could sell as much fertilizer as normal even though the temperatures are cooler, as buyers could be stockpiling in the belief that the fertilizer will have to be used sometime. The manufacturer would win on the sales and on the futures contracts. Likewise and slightly more contentiously the manufacturer would not have to reduce prices of fertilizer to encourage sales knowing that a futures contract is effectively 'backing his sales'.

The ski resort though warm may attract as many visitors as normal as some may not wish to miss a holiday break regardless and some may prefer to hike or bike which would not be possible in deep snow. There is no restriction on the ski resort exercising its futures contract even though it appears to win both ways.

However, if we take the fertilizer manufacturer example, let's imagine it expects revenue to be down by USD 1,000,00 in a cold spring and therefore shorts (sells) 500 CDD contracts at 400 at a price of 25 per contract. Cost is 500 times 25 being 12,500 USD.

But instead of the index being 300 the index is 350, giving a per contract return of 50 times 20, USD 1,000 and with 500 contracts USD 500,000.

Clear profit is 500,000 less 12,500 being 477,500 against an expected (required) return of USD 977,500, being sell at 400 for 12,500, buy at 300 returning USD 1,000,000.

Whilst this still offsets potential revenue loss there is considerable volatility in whether it will actually replace such loss. However, in the absence of the weather derivative the whole USD 1,000,000 would have been lost. From the derivative side the argument is that the weather was not as cold as expected and therefore fertilizer sales should not have been completely depressed which assumes a more direct correlation than may actually exist.

Relevance and use in managing climate risk

The growth in the weather derivative market, not only in type but in range of industries employing them, is testament to the increasing application of the market to high frequency, relatively low risk/value transactions. The move from what was almost exclusively an over the counter and therefore opaque market into exchange trading has extended the access to the market and allowed considerable extension of risk management for some weather risks.

It has been demonstrated that the uncertainty around exact returns may put off some potential beneficiaries of such a market but the separation of loss from return is also an attraction where pure hedging is already employed on other futures particularly currency and interest rates.

So far relatively few cities are taken as index references and using these as proxies for much more local weather conditions carries potential risks of its own. The fact that London is in a heatwave does not mean that Aberdeen is, and very local requirements are not best catered for via weather derivatives.

It is a market set to expand and it is quite easy to see that hedging across territories and types of weather could generate a very easily accessible market in the face of changing climate.

Biography

Julian Harpum

Julian has a degree in environmental science, am FCII and hold an MBA. Environmental Science provided a background into the scientific and mathematical analysis around climate change and his work as an underwriter in the first part of his career enabled some linkages to be made.

The MBA followed a more financial route which developed Julian's interest in the effects of climate change on financial markets and whether these bear any analysis. This led him to move into a more financial role and it is this aspect of climate change that he is most interested in.