

UNDERSTANDING AND HEDGING NATURAL CATASTROPHE RISK IN A CHANGING ENVIRONMENT: A (RE)INSURANCE PERSPECTIVE

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ABSTRACT

Relatively low frequencies of major atmospheric catastrophic events with high insurance penetration have left insurers and reinsurers in profit over the last decade despite falling insurance rates and climate change. Namely reinsurers, i.e. those companies that globally diversify risk and insure insurers, have enjoyed: 1) an unprecedented drought of landfalling hurricanes; 2) low activity in devastating extratropical storms in Europe; and 3) low loss activity from Japanese typhoons. This last decade of moderate losses was only interrupted by this year's hurricane activity with HIM (Harvey, Irma, and Maria) creating insured losses of around USD 100 bn – less than half of the losses that were expected over the last decade. Fuelled by low dividends in the capital market and high non-correlating returns from insurance, investors decided to participate directly in the reinsurance market, i.e. changed their earlier strategy by pushing capital into insurance risk rather than insurance companies. Although having started (on a very small flame) as early as the mid-1990s, this ILS (insurance linked securities) market has exploded recently by adding a growing amount of currently 20% to the existing reinsurance capital. Investors for these ILS products include pension and hedge funds, fund managers, private capital, among others. 2% of the assets managed by pension funds alone could replace the global (re)insurance capital herewith making it possible, if not very likely, that natural catastrophe (re)insurance risk will be managed differently in the foreseeable future. This paper deals with catastrophe risk in the insurance market as well as risk assessment and hedging in an environment that is both changing in terms of hazard and vulnerability but also in its means to assess, assume and trade risk. These changes may bear unprecedented opportunities but also significant threats.

Keywords: insurance, reinsurance, risk management modelling, risk modelling, portfolio optimization, portfolio management, hedging, regulation.

1 INTRODUCTION

Insurance means crowdsourcing risk such that relatively small fees from many suffice to pay for the large losses that befall a few. Insurance allows growth and provides long-term stability to economies by mutualizing risk and securing capital to investments that would otherwise be too volatile to be funded. Insurance works best where risk is idiosyncratic, static, and pure i.e. where losses are unlikely to occur simultaneously, history explains the future, and losses are non-speculative, i.e. downsides for some do not become upsides for others. The above holds nicely for urban fire risk where losses are in general non-systemic, rare, and non-speculative (unless of course there is fraud). Large catastrophes however might become rather systemic for regional insurance companies as earthquakes, tropical cyclones, or floods may wipe out more than their annual premium base. To provide stability for individuals and firms and in order to secure investments, governments and regulators hence demand insurance companies to hold capital against potential large and systemic losses. The aim is to enable insurance companies to replacing destroyed stock and repaying loss of income for even very large and unlikely events far greater than the annual insurance premium (insurers are commonly capitalized to their modelled 1 in 200 loss year). Capital management and cost is hence at the core of insurance companies. Failure to provide or maintain capital determines failure of a company. In order to optimize capital and capital cost, insurance companies have



hence developed ways to hedge risk. This paper gives an introduction to the current major challenges insurance companies are confronted with and deals with recent developments in catastrophe insurance risk modeling and hedging in a changing environment.

2 INSURANCE, REINSURANCE, AND THE WIDER CAPITAL MARKET

2.1 (Re)insurance means minimizing capital cost

Insurance means both, reducing volatility and minimizing the cost of capital. A homeowner may lose a major stake of her equity in an urban fire. Insurance takes this volatility out of a homeowner's life. Urban fires or other idiosyncratic losses can be paid with the insurance premium. Large systemic threats such as storms or earthquakes that affect many policies may however impend the lives of insurance companies. Keeping enough capital to manage this "tail" risk is however expensive and the cost of capital may well surpass the profit of a local or regional insurance company.

Reinsurers i.e. those insurers that cover insurers are both, diversified and (in most cases) global. Reinsurance works as the same dollar can be used against several deemed not correlating areas and perils. The rationale behind this is that large events are unlikely to cluster in any given year. As capital can be used for more than one area or risk, returns on capital increase as long as business is profitable and the more it is diversified. Capital cost can hence be minimal for remote areas and perils. Reinsurance products may therefore reduce insurers' capital cost significantly. Without this, most regional or local insurance companies would not survive current regulation demanding them to otherwise hold up to more than 20 times their annual premium in capital. This very fact distinguishes insurance from banking and/or the wider capital market. The capital market needs to hold capital independently for each risk given that investment assets including equity is correlating in the tail of its risk distributions (e.g. financial crisis in 2008/2009).

2.2 (Re)insurance a small niche in the wider capital market

The insurance market is – with around USD 600 bn in capital and a few trillion in overall premium – small compared to the wider capital market where two per cent of the pension funds' assets could make up for the entire insurance capital. With complex risks and prone to large catastrophes and strict regulation, insurance has however not been considered an especially attractive market. Stock multiples have stayed below 2 or not much above 1 for most (re)insurers over the last decade. (Re)insurers have in addition lived from investment gains rather than underwriting profit until investments become challenged around the year 2000. Since then underwriting gains become the drivers for profit. (Re)insurers have subsequently put more effort in the insurance processes. With the capital market hardly investing directly in insurance risk and with a general need for insurance, (re)insurance companies however lived a rather isolated but good life where competition was kept non-disruptive. Focused on capital rather than underwriting technology or expense, companies such as Lloyds invented a model of syndicating capital where rather small underwriting groups could coexist without a major need for an economics of scale (other than for capital).

Underwriting cycles i.e. abundant capital in good years, as opposed to company failure and capital scarcity in bad years (after losses) allowed significant price hikes and reasonable levels of profit even with some rather "lazy" attitudes towards expenses. Price hikes after losses guaranteed capital influx. Natural and man-made catastrophe losses such as those from hurricane Andrew in 1992, the September 11 terror attacks, or KRW (hurricanes Katrina,

Rita, Wilma) of 2005 were however often followed by more stringent rules and regulations. Over the last decade strong regulation made companies further compete on more, rather than less capital herewith making the market more secure but bringing returns down. With a lesser number of companies failing after large events, further influx of capital (e.g. chasing increased rates after 2017 losses) added to a growing overcapacity in western markets. M&A activities flourished and increasingly larger companies compete for the same products. Stock multiples deteriorated further bringing the reinsurance average stock multiple close to 1. (Recent financial crises brought multiples up a bit – see below – insurance multiples are in general somewhat higher and closer to 2.) This suggests that expectations of large future profits are low for reinsurance.

Inequality in information and risk knowledge between insurers and reinsurers or between clients and insurers fostered in addition a strong intermediaries/broker culture. Intermediaries added value by both, linking clients to (re)insurers, as well as helping clients to understand risk. These services took further profit out of the market. The above led to overall expense ratios equal to or larger than 50%. This means that less than half of the customer's investment in insurance goes to the actual risk product. The other half stays within the insurance supply chain. Kunreuther et al. [1] also argued that fear (and may be bonus protection) rather than strife for returns pushed (re)insurance CEOs to buy more reinsurance cover than needed resulting in more stable but inferior net results despite this resulting in lower returns for investors. Within the small and relatively closed (re)insurance market, scarce insurance education in universities, and based on some rather protective strategies, most executive positions in the market were filled with people having similar ideas and knowledge. This inhibited new and/or disruptive concepts to enter the market. The processes of filling positions with similar ideas and people might be referred to as self-organized similarity (Scheffer and van Nes [2]). The market has hence shown remarkable resistance to disruptive technologies, disruptive designs, or disruptive cultures. The London market may act as a prime example for this, where Lloyds' syndicates cherish their rather antiquated system of brokers bringing business (physically i.e. in paper form) to the underwriting box.

3 CATASTROPHE RISK AND RISK MODELING

3.1 Catastrophe risk drives overall profits and losses in the reinsurance market

Catastrophe products became the driver for gains and losses (especially for the reinsurance market). Significant volatility demanded significant returns in good years despite high expenses and growing competition. Profits for other lines of business became however suppressed with high expenses and redundant capacity. Low catastrophe losses in a year means high profits for most (re)insurers whereas larger catastrophe events mean that an overall loss is likely. Other lines of business have added little to this formula (at least for reinsurers).

With the above, and with catastrophe losses below the expected mean around USD 70 bn in most years between 2005 and 2017, as well as a strong focus on underwriting risk rather than investment gains, (re)insurance companies returned well and looked rather resilient in the financial crisis years 2008/2009 (see Fig. 1 for losses). This sparked the interest of the wider financial market. Despite rising awareness of climate change, stifling regulation, skyrocketing exposure, high competition, low stock multiples, and high expenses, insurers had not only outperformed the financial market in those critical years but had also created significant profits in most years.



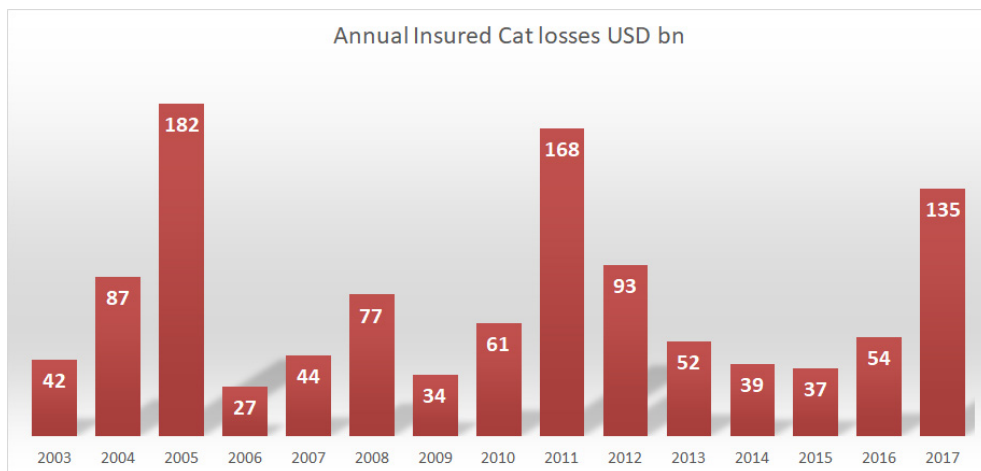


Figure 1: Annual insured catastrophe losses around the globe, inflated considering exposure and value growth, among others. Numbers are not unique due to differences in the methods used and published numbers vary (own study).

3.2 Catastrophe risk modelling a requirement for hedging catastrophe risk

Insuring assets (from car-owners and homeowners to large firms) as well as transforming risk to the wider capital market demands tools quantifying: a) the exposure and its susceptibility to loss; and b) the correlation of risk in a portfolio and hence capital cost. Hedging risk requires a reference or “currency” all counterparties need to agree on in order to trade. Experience of historical losses may not explain future catastrophes especially for those areas where large catastrophes are rare. Around 25 years ago a few vendors emanating from among the best US universities started to build models that answered the needs for (re)insurance. These models have been providing: 1) deemed complete (as opposed to a few large deterministic events) stochastic event sets; 2) translated hazard into losses; and 3) included financial models that relate insurance policies to risk and losses.

Without sufficient historical loss information, models needed to go back to hazard and exposure considering that risk equals likelihood times impact with impact being the product of exposure and vulnerability (Michel [3]). Although this approach has severe drawbacks, this at least allowed the use of rather rich hazard data. It also allowed modelling risk consistently from the ground-up. Downsides include the fact that heavy calibration is needed, higher with increasing resolution and the larger the numbers of variables (Michel [3]). Vendors needed to make up for missing information with assumptions. With higher demand for precision came an increasing number of variables often difficult to calibrate against rather scarce loss (and other) data. Accuracy of recent large loss forecasts from these vendor models seem in addition not to increase and actual completeness of modelled losses to actual losses still ranges below 60% for major loss years (2005, 2011, 2017, Fig. 2). Over the last years, availability of data and data methodologies have however soared and radically different thoughts and methods might allow future models to cover risk more directly.

With existing trust in models and deemed complete event sets, almost any financial instrument can be implemented in the catastrophe risk trades. Tools are deemed scalable with each deal becoming a vector (tensor) in an increasingly complex portfolio of accumulated

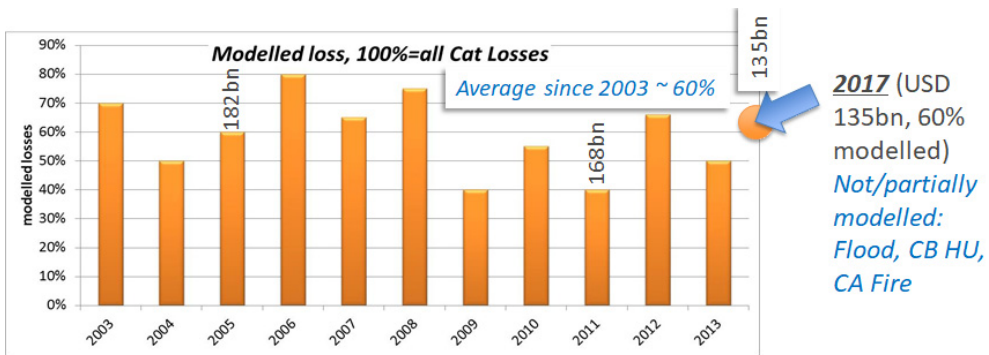


Figure 2: Modelled loss in % of overall losses from 2003 to 2013 and for 2017 in comparison based on published penetration of vendor modelled perils. Major loss years are denoted by inflated losses. Inflation methodologies are not unique and depend on changes in exposure, vulnerability and alike. A significant trend towards more complete modelling is not evident.

multidimensional risk. With correlation and uncertainty being transferable across scales, rather seamless trading is enabled across a wide risk spectrum. With each risk being an incremental part of the overall portfolio comes an incremental amount of capital allocated to each deal. With this, portfolio optimization using Monte Carlo (or similar) methods started to make sense. Optimizations are conditioned on targets such as return on capital (ROC/ROE), return on premium, return on assets or alike. Today, portfolio optimization is part of daily underwriting with scenario portfolios being tested in quasi-real time against various efficient frontiers (Yiptong and Michel [4]).

The larger the portfolio and the more diversified it is, the better defined are model results. This is due to the fact that high-resolution inaccuracies tend to get diversified away in the models when looking at larger scales. In any case, it has so far been more important that models enable trade than models being accurate down to local details. With higher model complexity (and more assumptions being built into models) came the need for trust in vendors. Only a few large modelling vendors had the scope and stamina to become long-term trusted partners. Two major firms sustained these challenges. These two companies (RMS and AIR) have dominated the market for the last 10 years. More recently, however, a new ecosystem of modelling vendors evolves that may replace part of the older supply chain.

Markets did make models and models have made markets such that the higher level of complexity a model allowed the more sophisticated trades happened. Trade was however concentrated to western societies where insurance penetration is high. High insurance penetration meant richer markets which was followed by an abundance of models which again resulted in an even larger concentration of capital there. With the new ecosystem of small model providers this is however changing and there is hope that we might fill the insurance gap in Asia, Latin America, and Africa over the next decade.

Trade is so far best done if the market agrees on a technical outcome e.g. the expected loss (integral over risk curve) for a deal. Trading in the rated insurance market allowed significant ranges in technical results. This is opposed to the capital market that prefers to communicate rather precise point estimates to their investors (despite often large uncertainty). The struggle of which model results to agree on is however not solved for many products. Agreeing in what is both prudent and sufficiently pragmatic to do a trade with,

remains a challenge. This is not only because of the large uncertainty any expected loss might bear but also the fact that uncertainty of a deal changes within a portfolio of risks. Trading even complex deals with millions of underlying policies may need to happen within relatively short amounts of time (hours). The more companies understand modelling, the easier it becomes. Experienced regulators have started to understand that not one specific vendor model but rather the principals and rationales behind a model matter along with how well the model allows consistent hedging (unfortunately not all regulators are sufficiently educated and understand the underlying trade-offs).

Although models have been used for pricing individual risks, the much larger value of vendor models lies in their ability to calculate and hedge tail risk and optimize capital needs. Most (re)insurers run multiple models with internal models driving their own risk appetite and tolerance whereas vendor models are used to communicate and hedge risk.

Most vendor risk models are in addition not audited thoroughly. Exceptions include the US Florida Hurricane model (Lee [5]). Despite of the above, risk modelling is still a young science and the use and calibration of models might not be without flaws. One of the most common mistakes auditors might find is that individual model components were adjusted independently, based on e.g. some historical loss or hazard knowledge rather than considering overall loss results for the model as a whole. Doing this is likely to increase rather than decrease biases and leads to rather misleading offsets in frequency and/or tail risk. As a general rule, never let a person who has never built models try to adjust models, this is very likely to fail – although evidence for failure might surface much later.

4 CHANGING THE REINSURANCE MODEL: CAPITAL MARKETS INVESTING DIRECTLY IN UNDERWRITING

4.1 Capital markets investing directly in catastrophe underwriting

Although the wider capital market has supported the insurance market over all its existence, investments were into insurance companies rather than directly into insurance risks. (Re)insurers accumulate assets that are invested in the bond and capital market: the more mature an insurance company is the more it holds assets that correlate with the wider financial market. These assets are held predominantly in low risk government bonds at low returns rather than being invested in higher returning (but riskier) equity. Covering entire (re)insurance companies was hence suboptimal for investors. Interest in further direct investments in insurance risk rather than insurance companies hence grew. This led to further influx of capital into a rather small insurance linked securities (ILS) market. The ILS market was dominated by relatively inflexible and labor intensive catastrophe bonds before 2008. Since then collateralized fund and insurance vehicle creation soared and the ILS market constitutes around 15% (20% of reinsurance market) of the overall insurance capital at the beginning of 2018. Most of these assets are held against catastrophe risk in the US (mostly hurricane) because a) it was deemed highly profitable despite high expenses; and b) vendors had created models that made calculating and hedging US risk rather easy.

Modelled global insured average annual losses range around USD 70–80 bn with the corresponding economic losses ranging around USD 300–400 bn. The difference between 70 bn and 300 bn is what is not insured. Not insured or underinsured in most western countries are both, infrastructure risks as well as perils such as flood and earthquake. Much of the risk in Central and East Asia, outside Japan, as well as in many areas in Africa and Latin America are largely underinsured. The lack of insurance in these areas is referred to as the insurance gap [6].



An unprecedented hurricane drought in Florida between 2005 and 2017 has pushed one of the highest paying and – before 2006 – least performing markets into strong profit. Hurricanes make up for 40–50% of the global insured natural perils' risk, and Florida hurricane risk accounts for roughly half of this. US and especially Florida hurricane risk have since become a main focus for collateral investors. Technical (modelled) returns looked in addition highly profitable despite increasing competition and falling insurance rates.

Insurers are in addition (in most areas) not allowed to accumulate funds as retained profits from good years other than in the form of capital. Higher capital however means lower returns for investors. Without large growth options in an anyway overcapitalized market, companies opted to buy back shares rather than holding more capital or acquiring other companies.

The 2017 year has created insured catastrophe losses between USD 130 and 140 bn (>80% in the US). USD 100 bn of these were due to US hurricanes and up to 20 bn due to California wildfires. The rest were smaller catastrophe losses around the globe. This kept most companies at a moderate loss, breakeven, or with only small profits. 2017 created also the first test for the ILS market with their first significant losses in the catastrophe insurance space. Ideas predating these losses – that the capital market will abstain from writing catastrophe risk after realizing losses – were counterfeit. Additional direct investments in insurance risk started to soar after the events assuming that prices will increase (hard market).

5 HEDGING CATASTROPHE RISK

Trading in the insurance market is commonly done via emails (or on paper in the traditional Lloyds market). Currently discussed platforms [7] will further automate trading in the near future. Platforms such as PPL however replace only part of the current transactional workload.

Straightforward forms of catastrophe hedging include insurance and reinsurance as explained above. Creating a deal involves various specialists including underwriters, risk modellers/actuaries, legal specialists, claims administrators, and alike. Most of the involved products include an expected or modelled mean loss uplifted with expenses, capital cost, and margins. The overall price is negotiated and may well be significantly below the modelled expected loss depending on redundant capital and/or variations in the view of the considered risk (players may entertain models that deviate largely from the vendor model results).

5.1 Forms of reinsurance programs/hedges

Most reinsurance products include an ultimate limit although some deals exist that transfer a share of quasi-unlimited insurance. Unlimited means that no matter how large a loss, it is always shared on a pro-rata basis (i.e. only limited by the underlying exposure). Pro-rata shares capped at a certain more manageable limit have however replaced most unlimited deals given the high and often uneconomical tail risk involved in these deals otherwise. Pro-rata shares are often considered unnecessarily expensive as high frequent small losses – and high levels of premium – are hedged along with large losses. This may be seen as unnecessary because most companies can afford holding higher frequency losses.

Other deals include slices of risk. These “layers” (Cat XoLs) leave the higher frequency range to the cedent whereas higher severity risk might be ceded out to the counterparty. The highest severity risk (e.g. above the 1 in 100 to 1 in 200) may be kept net by the cedent as well. Cat XoL layers may include individual events or may cover all events in a year. Deals can become increasingly complex including changes in layering for different perils, successions of events along with possible step-ups or step-downs in cover depending on certain loss conditions. They may include annual caps or change territories or perils for



different events in a succession of events. Within the “rated” (re)insurance industry (that diversifies capital), deals are based on a promise to pay and counterparties hold their capital back until the actual loss happens. How much risk a company might want to offload from their balance sheets depends on both, their risk appetite as well as their aspired credit rating and regulation (the higher the rating the larger the needed capital). The primary cause for risk hedging is capital cost but other reasons include minimizing performance volatility or arbitrage (hedge might be cheaper than holding the risk even for the high frequency range). Other reasons might be “relevance” i.e. that a company wants to have a market presence much larger than their balance sheet and hence offloads risk widely across the risk curve. Another reason might include freeing up capital for M&A activities. In the more mature rated market some deals might simply be there for historical reasons (and in order to keep the counterparty close in case needed otherwise later). Many (re)insurance companies still hedge based on the risk appetite of their senior underwriters rather than on what the overall portfolio might demand technically. This includes buying quota shares rather than XoL layers for catastrophe business. Risk managers might find that net result for such a company can be significantly worse than gross results (especially if expense ratios are high).

5.2 Transforming/securitizing insurance risk

Most (re)insurance hedges stay within the (re)insurance industry. The number of transformed/secritized risks moving from the rated market into the collateralized market however increases rapidly. Securitizing risk means transforming risk from the regulated insurance market into the capital market. This transformation includes a shift from “a promise to pay” in the insurance world to holding the required capital against a deal for the collateral market. Both versions have their pros and cons but reasons why the former is more abundant than the latter is rooted in insurance being traditional and relationship driven. Downsides of the rated market solution include its (relatively) small size, its internal correlation (global carriers often share similar risk profiles), its resistance to change, as well as its high costs. Upsides includes trust, the promise to pay, its long-term focus, as well as its ability to diversify risk and cope with increasingly complex regulation and licencing processes. Large future losses can mean that hedging becomes subsequently more expensive and that capacity may become uncertain in case players are taken out or do no longer have the right to hedge due to losing their credit rating.

Credit risk is smaller in the capital market where capital is secured (often in cash) before the deal emanates. Expenses are again much lower for the securitized (or collateralized) market than for the rated market. High capital needs for US catastrophe risk hence makes it likely that US risk will move rapidly into the capital market which is opposed to the international market outside the US where risks can be largely diversified. So far insurance risk (in the ILS market) requires freezing capital in for a certain amount of time (often 1–2 years) resulting in restricted liquidity. This is opposed to trading catastrophe bonds or Industry loss warranties (ILWs). The latter are loss trigger products based on industry losses monitored by agencies such as Perils [8] or PCS [9]. Upsides of these products include rapid pay-out after losses due to agreed cut-offs and extrapolated losses for the trigger products. This is opposed to indemnity losses that evolve over years. The downside of ILW products comes from the fact that industry losses may be quite different from the company losses you might want to hedge for and basis risk might hence be high [10]. More recent products involve disaggregating actual losses e.g. down to county levels. Hedging at varying multiples to actual county losses might hence allow minimizing basis risk. Catastrophe bonds are increasingly based on indemnity or may be based on trigger products. Trigger product include

parametric solutions and use physical or statistical means to approximate risk. Trigger products can include derivatives of windspeeds, earthquake intensities, or alike. These derivatives include statistical means that transform hazard into losses. Catastrophe bonds have been rather expensive in their set up involving modelling agents, brokers, asset rating, and legal work. More recently, so called “cat bond light” products aim at making the process quicker and more affordable.

As mentioned above, hedging risk is subject to regulation for insurance companies and may involve scrutiny from tax controllers depending on where hedging takes place (often in low tax regimes such as Bermuda, Guernsey, the Cayman Islands, or alike). Future creation of trading platforms may aim at allowing faster securitization, further standardized risk measures as well as pre-agreed and/or more flexible wordings. Product mix will increase and it will be easier to hedge not only short-term catastrophe deals but also longer-term policies such as energy, casualty, or cyber risks for which losses may unfold over multiple years. Repackaging risk and hedging on commoditized platforms that include creation of policies along with running a choice of free models, might just be around the corner. New technologies such as block-chains might lend itself well to these operations given stronger regulations and the need to keep detailed data private and possibly never physically leaving some secure cells [11].

As the primary task of risk hedging is to minimize capital costs, swapping peak risk with counterparties that show large differences in risk concentration can make a lot of sense. Catastrophe swaps have started before 2000 and were more abundant 5–10 years ago where large insurance companies were still more local (e.g. Japan or US insurance companies writing mostly JP or US risk). Today large insurance companies are rather conglomerates/agglomerates of companies across the globe with a stronger ability to diversify capital. With lower capital cost comes lower prices for hedging. Insurance prices are likely to deteriorate further until the level of pain (eroded profit) makes investors remove their capital from the market. This is however not in sight, probably as long as companies can reduce costs and increase efficiencies further.

6 INSURANCE IN A CHANGING ENVIRONMENT

From the above, we may follow that: 1) despite its global penetration, insurance still operates as a rather “niche” market only recently effected by external competition; 2) moderate to low catastrophe losses over the last 10+ years has allowed for reasonably high returns despite high expenses and large competition; and 3) high complexity and demanding regulation might hinder external competition to take over quickly (we might argue that regulation made insurance more resilient but also made it much less competitive). Resistance to change has been high within the insurance market but influx of cheaper capital has started to create the awareness it might deserve. News about companies reducing costs are in the press every week with e.g. Munich Re having announced to lower its reinsurance workforce significantly replacing underwriting stuff with a lesser number of data scientists. Investments in “Insurtech” (Braun and Schreiber [12]) have in addition reached a new record of above USD 1 bn and market places such as the US, Bermuda, or Central EU are discussing more radical changes to their company structures. This includes involvement of multi-channel front-end distribution, inheriting a wider ecosystem of small service companies, and alike. Given common resistance to change within larger operations, two-speed cultures have become operational and many of the European insurance companies have been launching nimble working groups and are partnering with efficient service providers. The London market seems to resist change more efficiently and may retain their expensive reporting and back-office setups longer. This has many reasons, one may simply be culture. Another reason may

be rooted in the advantage of having broad licenses across insurance and reinsurance which still allows for stock multiples close to 1.8 for those who are publicly listed companies in Lloyds (despite underperforming compared to the global market in 2017).

Change management ideas include: a) insurance companies becoming service providers in addition to risk carriers; b) insurance companies will speed up transforming risk herewith writing predominantly on the balance sheet of others; and c) insurance companies aiming at changing their own and their clients' culture by creating awareness for a more resilient future. The latter includes shifting risk mitigation ideas to their clients. This could include educating clients about resilience, packaging risks and insurance in more appealing policies, monitoring of risk more directly as a service, rising awareness about health and a culture that values security as a source for well-being. The prime idea is to change insurance products from being dull and necessary to insurers becoming partners in the everyday life of their customers. Examples for services might include cyber policies that provide active IT support after an attack.

The general notion is that risk mitigation will lower risk and hence capital needs for insurance companies. Cost will however always play a role and insurance is likely to further commoditize.

6.1 Climate change and the change in natural and man-made catastrophe risk

Climate change scenarios suggest that frequencies and/or severities including correlation of climate risk might increase herewith challenging the concepts of crowdsourcing and diversifying capital. Climate change has hence been discussed as a potential limitation to the concept of mutualizing risk. One example for this is the notion that future hurricanes will have a much larger likelihood of becoming major hurricanes (which might already be the case) given that higher SSTs fuel storm formation [13]. Recent data however suggests that risk mitigation outperforms climate change in many areas around the globe and that increases in risk may not be visible in the insured loss data (Bartel and Neumayer [14], Daniell et al. [15], Simmons et al. [16]) showed that that recent natural catastrophe losses are decreasing despite increase in frequency and/or severity. At least short-term (annual) policies are so far unlikely to see changes in rates due to climate change (neither up nor down).

6.2 Cyber risk, threat or opportunity

Protecting our largest equity – which has been for many of us our homes – along with covering motor business, life, and health have been a major focus for insurance around the globe. Economic losses of around USD 300 bn to 400 bn per annum were only deemed exceeded by speculation losses from the capital market. Extreme insured property losses for individual years or events were in addition considered to stay below USD 500 bn. The most extreme economic losses may however be due to earthquakes (e.g. the repeat of the great Kanto earthquake affecting Tokyo in Japan). Earthquake insurance penetration is however small e.g. for the US or JP with insurance companies in JP considering earthquake losses “uninsurable” (only around USD 30 bn of the 300 bn Tohoku earthquake losses were insured). In addition, natural perils are deemed non-correlating in any one year (although clash might happen). Losses from natural perils are deemed finite in both space and time and most policies covering natural perils are short-term, i.e. losses are largely understood one year after a catastrophe has hit an area.

The above however contrasts with cyber risk. Annual average economic cyber losses are much less transparent than natural perils losses and economic cyber loss estimates range



between USD 600 bn and USD 3–6 tn annually. Most of the involved events are unlikely to affect property but rather result in direct or indirect loss of profit, losses of reputation, i.e. share price, along with altering access to all levels of supply chains, capital or alike. Reputation risk, e.g. stemming from “lost” credit cards, and personal data is high and companies might not be interested in getting losses published. Defining events becomes difficult given that that computer viruses may have stayed dormant for years and/or affect companies for a long time until they may be detected. Cyber-attacks can (and often may) be global and correlation of losses between clients and markets might be large. The cyber market is in addition likely to grow rapidly and we might argue that companies are deemed unlikely to ever be fully in control of their data. Cyber risk is also likely to be speculative, can be quasi-unlimited, and may include fraud (all what speaks against the “classical rules” of what is insurable). Cyber is however likely to become the new “hurricane” requiring far more than the excess capital currently considered for the market. So far insurance penetration for cyber is however small and global insurance losses might range below USD 1 bn annually (2017).

7 CONCLUSION

We conclude that (re)insurance is likely to change significantly over the coming years. This includes erasing inefficiencies and minimizing costs as well as increasing service and fostering awareness for risk mitigation. Residual risk from natural catastrophes will shrink rather than grow in the western world despite climate change. Excess capital might find its way towards Asia and might gradually fill the current insurance gap (may be with very different future products). The capital market is likely to take over high severity risk mainly for the most exposed and capital-intensive areas such as those along the US coast (areas in Asia might follow). The traditional insurance market might retain the lesser returning and higher diversified risk in Europe and other areas in Asia, Latin America, and finally Africa. Weather risk hedging will see increasing interest given climate change, rising general awareness, and additional focus on the higher frequency losses given shrinking tail costs and cheaper insurance. With the above, we assume that our culture will change towards valuing “safer-environment” – policies with customers caring about risk in their everyday life much more than they do now.

ACKNOWLEDGEMENT

I would like to acknowledge Chaucer Syndicates for their support.

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