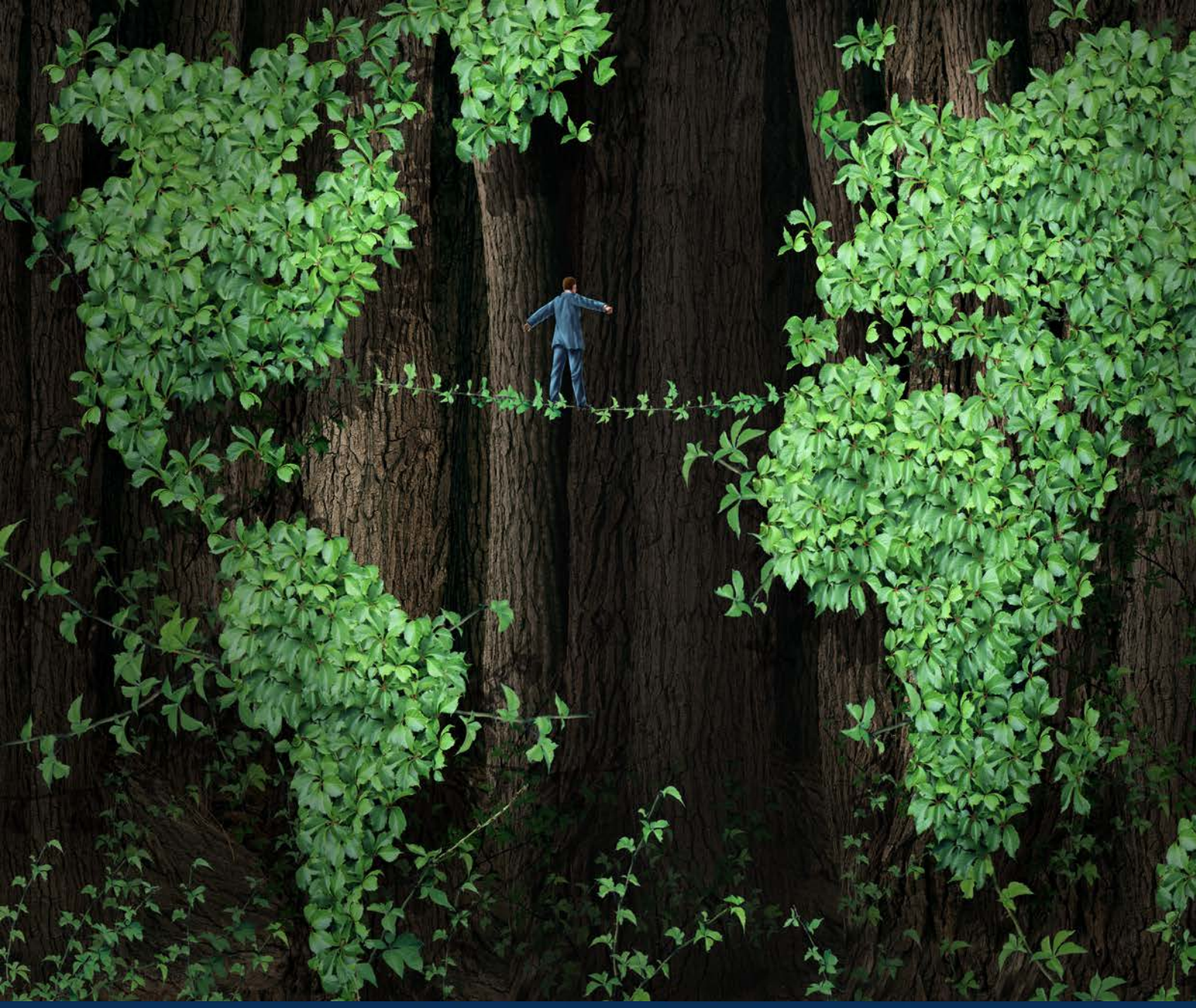

Casualty Accumulation Risk

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CRO FORUM

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1 Executive summary

Casualty accumulation is the concentration of insured risks or insurance coverages that may be affected by events or circumstances that cause substantial losses under several insurance policies, and potentially over multiple years and geographies. In the past, casualty accumulation has led to well-known claims complexes such as asbestos, the Mont Blanc Tunnel accident and the Deepwater Horizon event.

The increased interconnectivity and interdependency of the world due to globalization, technology advances, regulatory changes and macro-economic factors heightens the challenges faced by the re/insurance industry in terms of detecting and managing accumulation potential within the casualty portfolio. As supply chains span countries and companies, and new technologies develop, the risk of casualty accumulation increases. Monitoring these developments is a priority for a Chief Risk Officer.

Casualty catastrophes can be classified into three categories:

- Sudden and accidental events, which we call *classic clash*, (eg, Mont Blanc/Deepwater Horizon).
- *Serial aggregation losses*, where multiple insurance policies are triggered out of one single defect, such as losses linked to the hazardous properties of diacetyl.
- *Systemic losses*, where a repeatable process/procedure or industry/business practice results in a series of losses, such as IPO laddering practices in the financial industry.

Exposure analysis of a portfolio should include two aspects. Firstly, past/known loss complexes need to be managed and can serve as guidance for what could happen in the future. Secondly, the Chief Risk Officer has to keep in mind that past events have less predictive power, compared to property, towards assessing future casualty catastrophes. Asbestos is not going to be the "next asbestos"!

In property re/insurance, accumulation risk is geographically defined and easier to model. Casualty accumulation[1] risk modelling and assessment is more challenging. Current methodologies are based on statistical analysis of triangles, expert judgement and top-down calibrations. Modelling casualty accumulation is difficult in view of time dimensions of the exposures and also because societal trends can significantly alter the risk landscape. However new technologies like big data and new forward-looking modelling techniques have matured to a point where it may become possible to significantly improve the accuracy, prediction power and quality of casualty accumulation models. This trend should enable additional risk-taking activities, without loss of control over systemic and accumulating exposures. In parallel, in a deterministic approach, the industry has to build sophisticated and standardized scenarios for monitoring accumulation. These scenarios will help the industry better understand casualty accumulation risk, and allow it to test sensitivities aimed at setting limits for the risk.

Most re/insurers manage casualty accumulation risk by limiting coverage in their policy forms and keeping track and limiting aggregate exposure. The Chief Risk Officer can enable a controlled risk taking by sponsoring improvements in modelling techniques, and also by fostering better understanding of casualty risks by capturing essential exposure information and key coverage aspects on a standardized basis for the whole portfolio. Improved understanding of assumed

[1] Insurance ERM (2015), "A new breed of casualty cat model" Retrieved from https://www.insuranceerm.com/analysis/a-new-breed-of-casualty-cat-models.html

exposure through more complete data and better risk monitoring by building standard scenarios will support the development of new products. In turn, that will enhance the ability of the re/insurance industry to better-address earlier the casualty insurance needs of a fast evolving society.

2 Understanding casualty accumulation risk

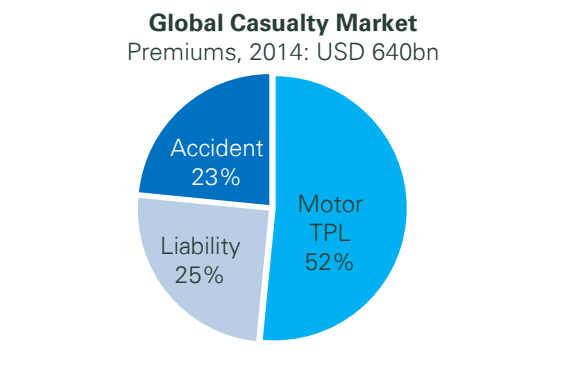
Large, devastating catastrophes do not often generate big headlines about casualty insurance. But there is a real risk associated with the possible build up – or accumulation – of known and unknown casualty exposures. It is essential that a Chief Risk Officer fully understands this risk, both from an historical perspective and in terms of the exposures and potential losses that could materialise in the future. By nature, casualty risks are correlated with the general economy and societal developments and, potentially, also with the investment portfolio of a re/insurance company.

The World Economic Forum Risk Report 2014 indicates that "over the past decade, risk management has assumed a much more important role in many firms across different industry sectors. In general, there is a trend away from technical planning for individual risks and towards holistic planning for a range of unspecified risks. A spate of crises and extreme events in recent years has convinced many companies that the benefits of globalization have been accompanied by a much greater degree of interdependency and interconnectedness, bringing new vulnerabilities from unexpected directions." In other words, casualty catastrophes (ie, large loss events due to accumulating risks) are set to increase, and this will require the attention of Chief Risk Officers.

In this chapter the authors define a framework for classifying casualty accumulation risk and provide examples of large – and potentially catastrophic – casualty losses emanating from undesired concentration of risks. We review well known casualty-loss events from an accumulation perspective to show the broad spectrum of potential scenarios. In order to help Chief Risk Officers assess the future in a holistic way, we also discuss the implications of some emerging exposure scenarios.

The global casualty market

The size of the global casualty insurance market per 2014 is estimated at a premium income for primary insurance of USD 640bn. About USD 330bn, or 52%, is motor third party liability insurance, general liability is USD 160bn, whereas accident, including workers' compensation, is USD 150bn.



Source: Swiss Re Economic Research & Consulting

Global liability direct premiums totalled around USD 160bn both in 2013 and 2014, with 90% coming from developed and 10% from emerging markets. Liability premiums are expected to grow at a compound annual growth rate (CAGR) of 5% in developed markets and by 12% in emerging markets over the next decade, to a total of around USD 280bn by 2025.

Commercial Liability, 2013

		Premiums & GDP (USD billions)			Percentage shares	
Rank		**Liability**	**Total non-life**	**GDP**	**Liability/total non-life**	**Liability/GDP**
1	US	84.0	531.2	16,802	15.8%	0.50%
2	UK	9.1	99.2	2,521	9.2%	0.36%
3	Germany	7.8	90.4	3,713	8.7%	0.21%
4	France	6.8	83.1	2,750	8.2%	0.25%
5	Japan	6.0	81.0	4,964	7.3%	0.12%
6	Canada	5.2	50.5	1,823	10.3%	0.29%
7	Italy	5.0	47.6	2,073	10.6%	0.24%
8	Australia	4.8	32.7	1,506	14.8%	0.32%
9	China	3.5	105.5	9,345	3.3%	0.04%
10	Spain	2.2	31.0	1,361	7.0%	0.16%
	Top 10	135	1,152	46,857	11.7%	0.29%
	World	160	1,550	61,709	10.3%	0.26%

Note: Non-life excludes health insurance.

Source: Swiss Re Economic Research & Consulting, sigma 4/2014.

Within the casualty sector, accident (including personal accident and workers' compensation, health business is removed where reported separately) is an important line of business, with global premiums of USD 145bn in 2014. More than 80% came from developed markets, although growth in the developed markets is projected to slow and even turn negative in the next 10 years. In the emerging markets, premiums could grow by a CAGR of more than 16%. Global accident premiums are forecast to reach USD 190bn by 2025, with over half coming from

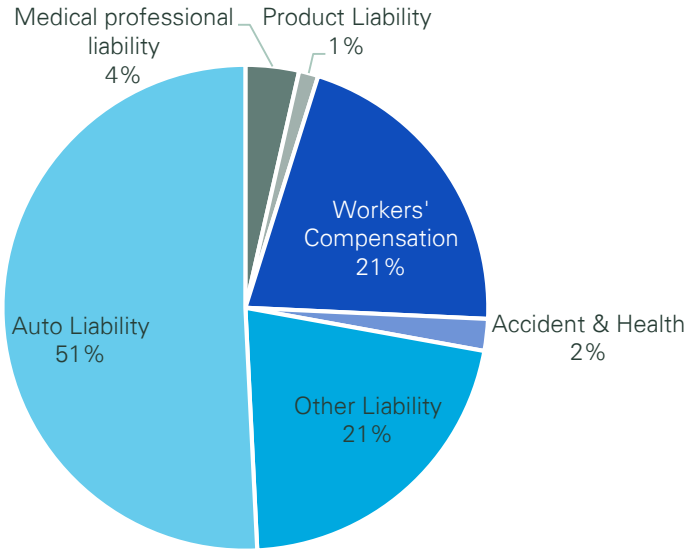
The US casualty market

The US is by far the largest casualty market in the world, due to the size of the US economy and the high penetration of liability insurance (0.5% of GDP). In 2013, US businesses spent USD 84bn on commercial liability covers, of which USD 50bn was on general liability, including USD 12bn on errors and omissions (E&O) and USD 5.4bn on directors and officers (D&O) policies. US businesses spent another USD 13bn on the liability portion of commercial multi-peril policies, USD 9.5bn on medical malpractice, and USD 3bn on product liability covers.

By line of business, auto liability direct premiums written in the US were USD 138bn in 2014, 51% was casualty sector premiums and about 25% was US P&C market premiums. The majority (84%) of auto liability premiums came from personal lines

The "other liability" line is the second largest category, with USD 58bn in premiums in 2014. It refers to the definition in the "schedule P" US reporting standards and includes umbrella business as the biggest segment not allocated to a specific line of business. Other liability is closely followed in size by workers' compensation with USD 56bn, each comprising approximately 21% of US casualty premiums. The remainder were from medical professional liability (USD 10bn), accident & health (USD 6bn) and product liability (USD 3.5bn).

US Casualty Direct Premiums Written, by Line of Business (2014)



Source: AM Best, Swiss Re Economic Research & Consulting

2.1 Defining casualty accumulation risk

Casualty accumulation risk originates from the concentration of insured risks or coverages that may be affected by events or circumstances that cause substantial losses under several insurance policies,[2] and potentially over multiple years and geographies. Such events are called "casualty catastrophes." They can be a single event, a complex of losses, or systemic events that generate large losses. In the following, we define these different types of scenarios and provide examples.

Classic clash

This is when multiple claims are generated by (a) sudden accident(s), occurrence(s) or event(s) such as the unexpected collapse of a building. The collapse can spark general liability, employers' liability and professional indemnity claims from a single insured across multiple classes, and/or multiple insureds across single or multiple classes.

Mont Blanc tunnel accident

The Mont Blanc tunnel connects Italy and France. On 24 March 1999, a truck transporting flour and margarine caught fire in the middle of the tunnel, creating intense heat and toxic fumes. The fire lasted 53 hours, 39 lives were lost and the economic damages were significant. Several parties involved in the catastrophe were sued and many motor third party, general liability and product liability claims were triggered. This example shows how easy it is for multiple parties including municipalities, security authorities, operators of the tunnel and manufacturers to be involved in the same casualty catastrophe.

Deepwater Horizon

On 20 April 2010, while drilling at the Macondo Prospect in the Gulf of Mexico, an explosion on the Deepwater Horizon rig killed 11 crew members. The resulting fire could not be extinguished and, on 22 April 2010, Deepwater Horizon sank leaving the well gushing oil onto the seabed and causing the largest spill ever in US waters. Multiple general, employer, product and environmental liability and also D&O insurance policies for multinational corporations were triggered to cover the resulting economic and environmental losses.

[2] There could be a liability catastrophe market loss which is not insured, but for our purposes, we're concerned with insured losses.

Serial aggregation

This is where a series of losses can be linked back to one problem. For example a defect in the design or manufacture of a product causes multiple losses, which can all be clearly linked back to the faulty product or a single corporate failure, out of which multiple professional indemnity and D&O losses could arise. Cases involving a single insured and single class are more likely to be serial aggregations than clash losses.

Diacetyl and the "popcorn workers'" lung disease

Diacetyl is a volatile organic chemical compound added to food to give a butter flavour. Workers in popcorn factories who have inhaled diacetyl for long periods have been found to suffer from a rare lung disease, bronchiolitis obliterans. The large number of companies producing and using diacetyl, and the relative young age of the work force exposed to it gives rise to a broad aggregation issue scenario. This is called the *serial aggregation* loss complex, triggered by one defect, in this case the production and use of diacetyl.

The Parmalat default

The bankruptcy of Parmalat is one of the most significant financial events in Europe. Driven by a mis- and non-transparent representation of the company's financial conditions, leading to a USD 20bn hole in its accounts, several banks, auditors and Parmalat itself have been involved in litigations. The example shows that even outside the US (with its high propensity to sue environment), a bankruptcy can be a casualty catastrophe event given the resulting accumulation of D&O and professional lines claims.

Systemic loss

Here, a repeatable process/procedure or industry/business practice, rather than a faulty product, results in a series of losses.

IPO laddering

An example of a systemic loss scenario is Initial Public Offering (IPO) laddering, which arose in the late 1990s as the tech bubble and stock market speculation fuelled a boom in IPOs. Laddering describes one particular type of claim against the practice of investment banks in which, as a condition for receiving an allocation of shares in an IPO, they get investors involved in another offering. With time, laddering has become a more generic label for a number of other claims arising from IPOs and the payment of undisclosed commissions to investors in exchange for preferential share allocation, or the obligation for investors to buy further shares in an issuing company post IPO. The common factor in laddering claims is the creation of a false market for shares. This has given rise to repeated claims by investors and regulatory actions against issuing companies and investment banks.

The above examples for casualty accumulation risk and casualty catastrophes align well with accumulation insurance products and risk management scenarios. A classic clash is similar in spirit to the standard per risk and per event casualty reinsurance treaties common in Europe and Asia. Serial aggregation is usually dealt with by batch clauses in insurance policies and also by product failure risk management scenarios, the best example being any asbestos-related claims scenario. A business disaster is sometimes used to model the capital requirements for D&O and professional liability business in view of correlation with market risk.

For the Chief Risk Officer, the key observation is that losses from casualty accumulations can arise from multiple sources and cover a wide spectrum of insurance situations. A proactive, open minded and visionary approach is needed to anticipate and avoid the next big surprise.

2.2 Examples of historical accumulation losses

Multi-billion casualty catastrophe cases are rare but over time, there have been a number of different events that together have caused billions of US dollars in insured losses. According to Towers Watson, since 1950 there have been around 300 casualty catastrophes that have resulted each in insurance industry losses of more than USD 100mn. Together these have generated more than USD 500bn in total costs for re/insurers.[3] This section reviews some of these events.

Asbestos

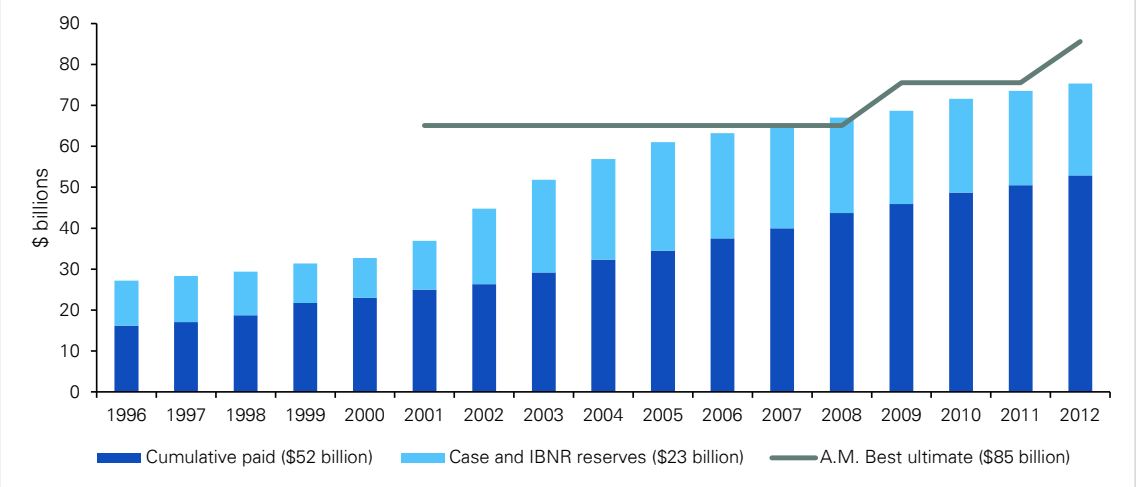
Asbestos is the largest insurance industry loss event in history, with total losses in the US Property & Casualty (P&C) sector alone estimated to be more than USD 85bn.[4] Asbestos falls under the serial aggregation type of casualty catastrophe. The economic damages arising out of occupational and general public exposure to asbestos and its resulting deadly disease, mesothelioma, consist of many of the characteristics global re/insurers consider to be a worst-case scenario. For centuries, asbestos was widely used in industrial and consumer applications until, and even after, scientific studies proved that it was harmful to humans. Claims arose across a wide spectrum of industries, with plaintiffs bringing litigation against multiple companies in many different industry sectors (eg, asbestos fibre manufacturers, asbestos product manufacturers, asbestos product distributors). In addition to the accumulation of losses across hundreds of companies spanning multiple industries, claims also accumulated over time. Due to the cumulative, multi-year nature of the manifestation of mesothelioma, courts awarded damages to plaintiffs spanning decades of products and policy years. Even today, plaintiff lawyers continue to find new ways to litigate on asbestos claims.[5]

[3] Ball, M., Jing, Y, and Sullivan, L. (2011). "The Need for Casualty Catastrophe Models: A Way to Prepare for the 'Next Asbestos'" . Retrieved from https://www.towerswatson.com/en/Insights/Newsletters/Global/emphasis/2011/The-Need-for-Casualty-Catastrophe-Models-A-Way-to-Prepare-for-the-Next-Asbestos

[4] A.M. Best Special Report (2015). "U.S. Insurers Continue Funding of Asbestos & Environmental Liabilities Despite Elusive End Game" Retrieved from http://news.ambest.com/presscontent.aspx?altsrc=14&refnum=22066

[5] Swiss Re Webinar (August, 2013). "What's Next For Asbestos" Retrieved from http://www.swissre.com/clients/newsletters/2013_08_claims_webinar.html

Cumulative Incurred Asbestos Losses – U.S. Property Casualty Insurers



Source: Towers Watson analysis of annual statement data compiled by A.M. Best and other industry data

The accumulation of losses across industries and time, the latency of mesothelioma and the long time it took the insurance industry to react with policy exclusions, has caused an annuitized drag on insurance industry profitability over the course of many years. As a result, highly accumulating mass tort risks as exemplified by the case of asbestos should remain a top concern for re/insurers and their Chief Risk Officers.

Deepwater Horizon oil spill

A blowout and explosion on the Deepwater Horizon drilling rig in the Gulf of Mexico on 20 April 2010 killed 11 workers and led to an ensuing 85 days of oil spillage, the largest marine oil spill event. The accident was tragic from many different perspectives. For the insurance industry it forced a re-think of the approach to managing sudden-event accumulation.

The explosion and spill generated claims across a wide suite of P&C products. For example:

1. commercial/marine property policies for property damage and business interruption;
2. workers' compensation cover for injuries/deaths[6];
3. public/excess liability policies for bodily injury;
4. property damage liability, including damages arising out of pollution in certain cases;
5. economic damages to shareholders of directly and indirectly implicated companies prompted D&O liability claims; and
6. Cameron, the manufacturer of the blowout preventer used on the rig was named in multiple product liability lawsuits.

The spill attracted contractors from many industries to the Gulf-region to assist with the clean-up effort, creating additional workers' compensation and public liability exposures. In addition, had the oil slick moved more closely to the shore, contingent business interruption claims could have emerged across a broad geographic area.

Tracking the linkages between geographical locations of casualty exposures is almost impossible without overly-burdensome data collection, storage and analysis. Nonetheless, individual re/insurers need to ensure they are not overly exposed to industrial explosion disaster events. Geographical

[6] There were 11 deaths in the blowout and explosion, of BP and Schlumberger employees.

concentration is a key consideration in the management of classic clash losses, and geographic information portals and maps can help ensure accumulation risk is properly reviewed.

The medical malpractice crisis in France

A recurring pattern in casualty insurance is that key legal decisions change the risk landscape, and often come in times of economic stress. For victims, liability insurance could be a potential source of revenue as the state legislates in favour of consumer rights in response to a particular situation, and at the expense of insurance companies.

The French medical malpractice market was historically written on occurrence triggers with unlimited coverage. In the early 2000s, this business was unprofitable and a landmark judgment passed in November 2000 by the Cours de Cassation in plenary session, called "arrêt Perruche", threatened to make medical malpractice uninsurable. The High Court awarded damages to a 19-year old teenager born severely disabled because his condition had not been properly diagnosed prior to birth. Payment for prejudice to be born disabled was thus acknowledged.

The whole market was hit by the decision and medical malpractice cover suddenly became very expensive, if at all available. Insurers with high concentration in medical malpractice faced difficult times and a series of reserve increases to cope with the new jurisprudence. To solve insurability problems and to ensure cover was available, at the end of 2002 the French government introduced several measures (laws called "Kouchner" and "About"), including establishing legal minimum limits of insurance cover for practitioners, and a move to a claims-made trigger. Finally, pools (Groupement Temporaire d'Assurance Médicale, GTAM, for insurance and Groupement Temporaire de REassurance Médicale, GTREM, for reinsurance) were created to share the most delicate and exposed risks. Since then obstetricians, anaesthetists and surgeons, those practitioners most exposed, are required by law to be insured. Premiums remain high, anything up to EUR 10mn, given that damages awarded in medical malpractice claims are significant.

Economic, societal and legal environments

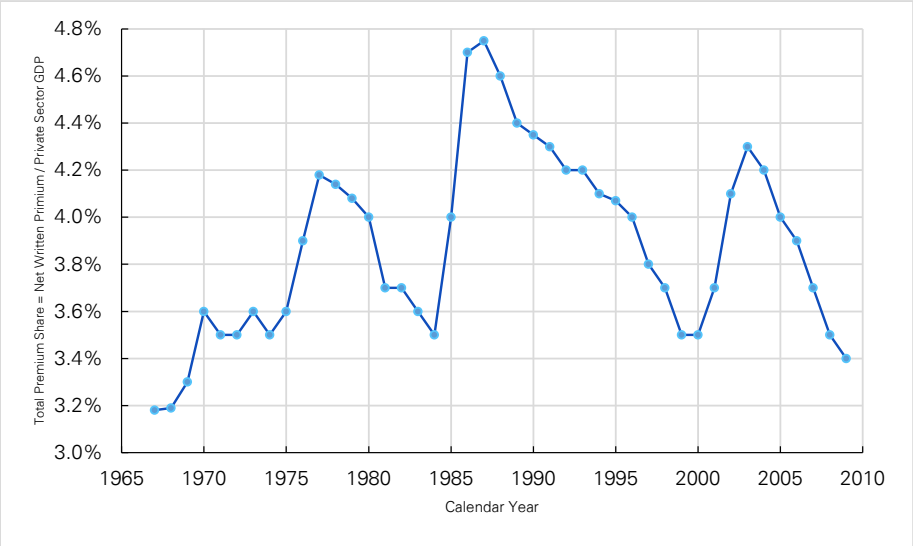
Claims inflation[7] is one of the greatest risks for casualty insurers. Most re/insurers' reserves assume historical average inflation rates for the claims payments expected to be made in 10-, 20- or even 30 years or more into the future. Periods of high inflation, both medical and general, can have a direct influence on claim outcomes. For example, the last period of prolonged high Consumer Price Index (CPI) inflation in the US was from 1974 to 1982. Many factors, including the US legal environment, influenced casualty incurred losses over that time period. However, in the late 1970s, there were significant reserve movements across the industry in the US, which could be partially linked to high CPI inflation.

Periods of high claims inflation (eg, medical, court rulings) can however also be disconnected from CPI inflation, making future insurance claims even more difficult to predict. For example, in France CPI inflation decreased over the period of 2002 to 2008 yet claims inflation for insurers was increasing significantly due to favourable court rulings for victims in bodily injury cases. More recently, most developed markets have gone through a period of low CPI inflation. However, cases of claims inflation can still be observed, for example driven by increasing bodily injury costs. The potential remains for a spike in costs that would cause accumulation of casualty reserve increases across the industry and globally.

[7] Claims inflation is not necessarily closely linked to widely published inflation indices like the CPI. Indeed, inflation of liabilities is often more strongly impacted by legal, social, medical and fiscal changes, and portfolio effects than by pure CPI inflation.

Casualty insurance products fundamentally cover litigation outcomes and costs. Therefore, casualty insurance books are particularly exposed to systemic changes in the legal environments within the countries in which their insureds do business. The time leading up to the mid-1980s was a historically significant period of increase in tort costs in the US. Thereafter many US states enacted tort reform laws which implemented various changes in their Justice systems to directly reduce tort litigation and damages. There was a clear trend downward in market prices post-1986, when many tort reform acts were passed.[8]

Total Premium Share – U.S. Property Casualty



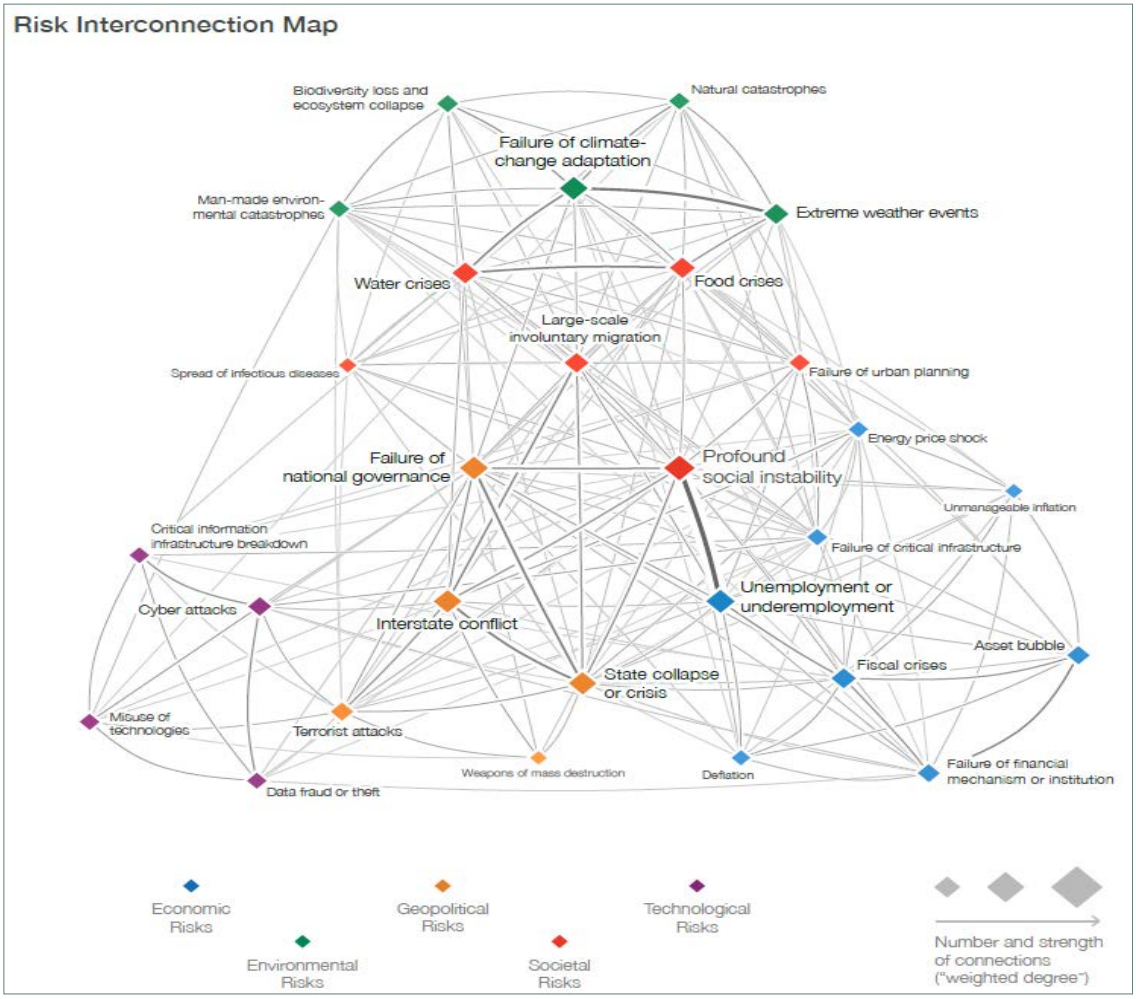
Source: Wang, Major, Pan, Leong (2010)

Similar trends, either upward or downward, will likely follow in other countries. There have already been cases outside of the US where legal changes have impacted casualty business. These cases have also demonstrated legal risk as a key driver of accumulation exposure. For example, the Courts Act 2003 and the 2008 court decision in the Thompstone vs Tameside case in the UK changed the landscape of compensation of bodily injuries entirely, moving away from structured settlements to periodic payments without the consent of either party, and with the use of an adjustment index in excess of the retail price index. The impact on the re/insurance industry has been significant and long lasting.

2.3 Casualty accumulation matters in an interconnected and fast evolving society

As our environment changes and evolves, casualty accumulation risk is steadily growing. The following Global Risks Interconnection Map visualizes the increasing cross-border interconnectivity and interdependency due to globalization, technology advances, regulatory changes and macroeconomic factors. These all increase potential accumulation risk.

[8] Nockleby, J.T., & Curreri, S. (2005) "100 Years of Conflic: The Past and Future of Tort Retrenchment" Retrieved from http://digitalcommons.lmu.edu/cgi/viewcontent.cgi?article=2467&context=llr



Source: Global Risks Perception Survey 2013-2014

With more connections between industries, insureds and countries, there is larger potential for casualty catastrophe events. Globalisation blurs the boundaries of countries and industries. For example, companies span continents, and the rise or fall of one currency can be felt within a company globally. Supply chains also span countries and companies and their growing complexity and interdependency magnifies the impact of small disturbances. As claimants seek compensation, they may try to sue every point in the supply chain, leading to an event which could spread across industries and insurance lines. The continuous aim to optimize and shift business processes down the value chain, including to outsourcing partners, can result in increased exposure for casualty insurers.

Technological and scientific advances are changing at lightning pace. As technology develops, it gives unprecedented access to information. Scientific advances also result in uncertainty around the long-term effects on and potential for risk accumulation in liability insurance. Alongside these increasingly interconnected risks, new forms of litigation make courts more accessible (eg, class litigations actions outside of the US may rise), which can rapidly change the risk landscape.

Insurers have learnt from past experience and introduced some key mitigants against accumulation risk in their products. Examples are the reduction of policy stacking risk, the use of claims-made or occurrence-notified triggers, and the adaptation of exclusionary language. Yet, the risk of a casualty

catastrophe has not disappeared. On the contrary, the risk is ever heightened by the fast changes in society and the way people do business and live their lives.

Asbestos as discussed earlier is the classic example of risk accumulation, but what could the next big thing be? We do not have a crystal ball but we are convinced that Chief Risk Officers should encourage their organizations to be opened minded about potential future scenarios. To spark discussion we will now look at some current hot topics and scenarios that could potentially be casualty catastrophe events in the years to come.

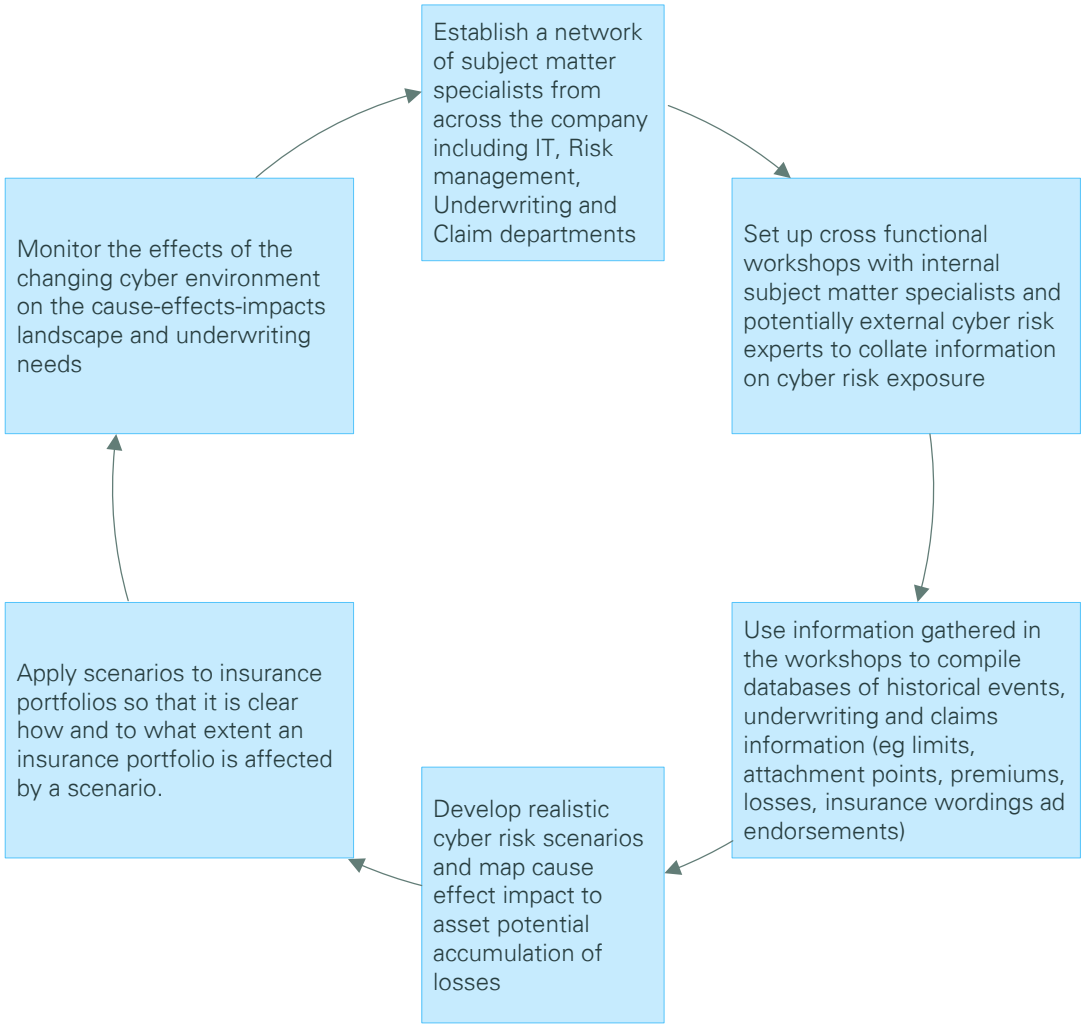
Cyber

Cyber-risk is defined as "the risk of doing business (in the widest sense) in the cyber environment or internet. This risk is evolving rapidly with technological changes, particularly as organisations compete to reach customers through the internet. As the environment becomes increasingly interconnected and complex, so the tools and sophistication needed to exploit vulnerabilities become simpler. Given the many ways that cyber-risk can affect the operations of a business, the costs and impact are uncertain and increasingly substantial."[9]

The potential for accumulation in cyber-risk stems from the highly interconnected IT systems that run the world today. This risk needs to be addressed if a successful insurance market to help manage the exposure is to be developed. The interconnectivity of IT systems hinders the ability to measure and monitor an insurer's cyber-risk accumulation exposure because a cyber-attack can trigger several insurance products and independent policies in a chain mechanism, similar to contingent business interruption. The challenge is further exacerbated by second- and third-order linkages, which are particularly difficult to identify and analyse.

In the CRO Forum paper "Cyber Resilience: the Cyber Risk Challenge and the Role of Insurance" written in November 2014 the accumulation potential of cyber risk was highlighted. The present paper "Casualty accumulation risk" proposes re/insurance risk management tools to address such accumulation challenges, therefore the cyber-risk case is highlighted again here. A key component is the development of scenarios to help understand the accumulation exposure, keeping in mind the factors that will influence the probability/severity of losses and accumulation potential. The diagram below sets out a process that can be used to establish and maintain a cyber-risk exposure accumulation framework.

[9] CRO Forum (November, 2014)."Cyber Resilience: the Cyber Risk Challenge and the Role of Insurance" Retrieved from http://www.thecroforum.org/cyber-resilience-cyber-risk-challenge-role-insurance.



Source: CRO Forum (2014)[10]

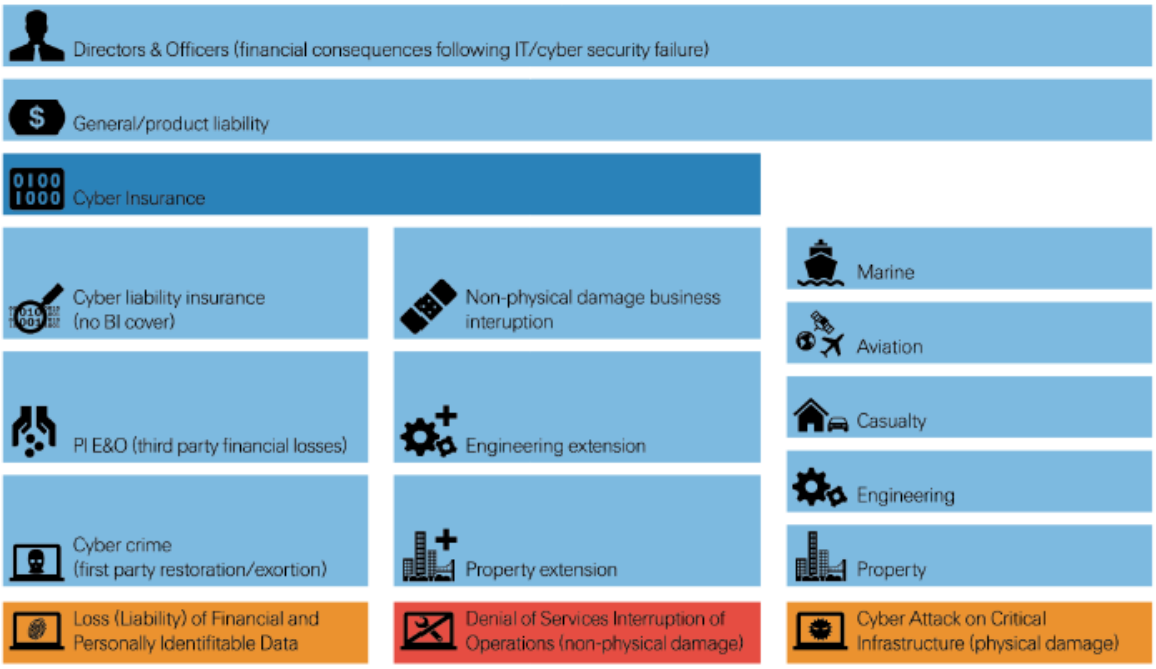
Key steps in the process involve:

- The development of realistic cyber-risk scenarios.
- An analysis of which insurance products are affected by which scenario, and to what extent.
- A catalogue of cause-effect impact maps to help insurers visualise the types of cyber-risks to which they are exposed and the damage that can be caused.

The cyber-risk landscape is not static. Developments in IT, dependency on IT services, the development of instruments and tools to identify and use system vulnerabilities, the motivation of hackers, and legislation/litigation may all change the results of an assessment of accumulation exposure. The framework must therefore be sufficiently dynamic to allow for regular scenario updates and for cyber-risk accumulation exposure to be monitored on an ongoing basis.

[10] CRO Forum (November, 2014). "Cyber Resilience: the Cyber Risk Challenge and the Role of Insurance" Retrieved from http://www.thecroforum.org/cyber-resilience-cyber-risk-challenge-role-insurance.

The diagram below illustrates the different lines of business that can be affected by cyber-risk, to various degrees depending on the scenario.



Example of potentially exposed insurance products.

Source: CRO Forum (2014)[11]

Pandemic

Pandemics are also a potential source of casualty accumulation risk. They occur when a strain of virus that can infect humans, cause serious sickness and is easily transmissible emerges or re-emerges. In a hospital, accumulation risk can stem from the institution's suite of professional and medical liability policies which are triggered if failures in protocol implementation result in new contaminations to staff or patients.

A pandemic outbreak also leads to higher medical expenses and healthcare costs. Business interruption and contingent business interruption policies can be indirectly affected by a pandemic outbreak as transport, cross-border trade, supply chains and tourism could become disrupted. Operational costs could rise to ensure business continuity, and a loss of new business could be expected. Further casualty exposures could arise from accident & health policies with sickness extensions or through workers' compensation, depending on the specific regulatory framework around occupational diseases.[12]

Nanotechnology

Nanotechnology is the engineering or manipulation of matter on a molecular scale. Products manufactured with some form of nano-engineered materials are becoming increasingly common.

[11] CRO Forum (November, 2014). "Cyber Resilience: the Cyber Risk Challenge and the Role of Insurance" Retrieved from http://www.thecroforum.org/cyber-resilience-cyber-risk-challenge-role-insurance.

[12] Boggs, C.J. (2014). "Is Ebola Compensable Under Workers' Compensation." Retrieved from http://www.insurancejournal.com/news/national/2014/10/10/343250.htm.

Nano-manufacturing processes can improve structures and properties of materials, making them stronger, water repellent, more durable, lighter, self-cleaning and more. Due to these properties, the use of nanotechnology can be expected to grow significantly. There may in the future be some similarities with asbestos, which for a long time was also considered "white gold" due to its superior properties. No link between nanotechnology and a specific adverse health outcome has yet been established, but should it turn out that some adverse health implications are connected with nanotechnology once the long-term effects are better known, the potential accumulation loss could be very significant.

E-cigarettes

E-cigarettes (as well as e-cigars and e-pipes) are a growing trend around the world. Available with or without nicotine, e-cigarettes are marketed as a cigarette alternative, smoking cessation aid, and as healthy and non-toxic. They are being used extensively across the US, Europe, and Asia. E-cigarettes are not strongly regulated and laws governing use and sale vary widely. In some cases, there are no regulations for product classification, product safety and quality, use in public places, youth protection and advertising. There are two major risks for the insurance industry: the technical component (battery, cartridge, etc.) and the chemical component (the liquids).

Currently, it is difficult to conduct a thorough risk assessment of e-cigarettes and the long-term health impacts are unknown. A loss-accumulation scenario could arise though if e-cigarettes are proven to be more harmful to health than presumed today. Respiratory diseases or other health problems may increase, triggering liability claims similar to tobacco claims already seen.

Concussions

Concussions are traumatic brain injuries that occur when a blow to the head or body causes shaking of the brain. Repeated concussions that are not identified and managed correctly have been linked to Chronic Traumatic Encephalopathy (CTE), a degenerative brain disease. It has been estimated that in the US, there are between 1.6 million and 3.8 million sports and recreation-related traumatic brain injuries each year.[13] This number is increasing each year as the number of young people playing contact sports grows and as many athletes become bigger and stronger.

In 2011 the first lawsuit was filed claiming that the National Football League (NFL) and Riddell – the "official helmet of the NFL" were failing to protect players from brain injuries and concealing the long-term dangers of concussions. Additional lawsuits have since come forward. On 22 April 2015, the Federal judge approved a settlement agreement which could cost the NFL USD 1bn in compensation payments to retired players.[14] The cases against Riddell are still pending.

Concussion safety laws related to youth sports have been passed in 49 states in the US. So, unlike before, concussions are no longer seen as minor injuries. It might very well be that advances in medical science may lead to new liabilities as the link between other injuries and concussions is made. At present, this is more a hot topic in the US than elsewhere, but there could be a spill-over to Europe and other regions. The large number of potential victims, including high-earning professional athletes or young players, could create a perfect storm and casualty accumulation risk scenario.

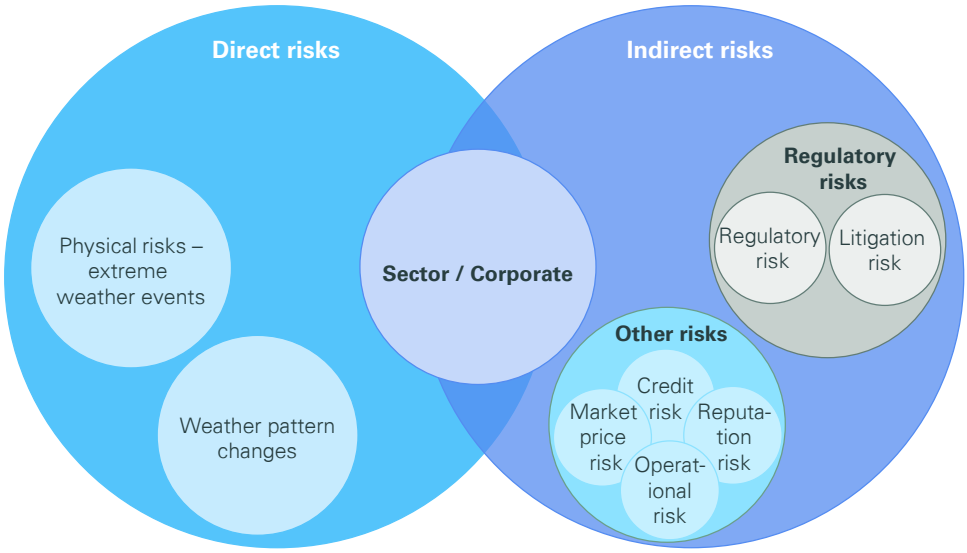
[13] Center for Disease Control and Prevention (CDC). "Facts for Physicians" Retrieved from http://www.cdc.gov/headsup/pdfs/providers/facts_for_physicians_booklet-a.pdf

[14] Associated Press. "US NFL Concussion Lawsuit". Retrieved http://hosted.ap.org/dynamic/stories/U/US_NFL_CONCUSSION_LAWSUIT?SITE=AP&SECTION=HOME&TEMPLATE=DEFAULT

Climate change

According to the US Environmental Protection Agency (EPA) "climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer." Man-made climate change in simple terms refers to the rise in the earth atmospheric temperature as a result of trapped CO2, methane and nitrous oxide. For the past 10 years, carbon dioxide emissions have grown by an average of 2.5% per annum.[15] This could amplify the risk for catastrophic weather events, like excessive heat, drought, rains or storms, a rise in sea levels and a thawing of permafrost.

Categorization of climate risk



Source: Carbon Disclosure Project(2007)[16]

To date there have been several climate-change related lawsuits in the US, but none have been successful. Potential liability cases could include failure to build or maintain infrastructure (eg, dikes, dams, well-functioning water ways, waste water/sewage systems, adequate staffing and material – direct-link liability[17]) to mitigate the risks posed by severe weather events. There could also be legislative actions to limit CO2 emissions (indirect-link liability), for which public and private sector parties could be held liable. In the current legal environment, it seems unlikely that indirect-link liability will be approved in court but if it is, the result would be a critical loss accumulation.

In the US, the direct-link liability is a reality and the potential for casualty accumulation after a natural catastrophe can be dealt with by the insurance industry. For example, following floods and hurricanes, pollution cases have been observed, and several cases of liability for construction or utility companies have already been seen. Amongst other reasons a greater willingness to hold

[15] Carbon Disclosure Project (2007). "Carbon Disclosure Project Report 2007" Retrieved from https://www.cdp.net/CDPResults/CDP5_FT500_Report.pdf

[16] Refer to footnote above.

[17] Definition from Coping with climate change risks and opportunities for insurers, The Chartered Insurance Institute 2009

other parties liable following a natural catastrophe as well as better investigation of cause due to the advances of science, increase the probability of liability claims after a natural catastrophe.[18]

As an example of an extreme weather event, a large wildfire started on 20 October 2007 in Southern California and continued for 19 days. Over 1200 homes were damaged. After investigation, it was found that improperly maintained and designed power lines ignited the fire and that the utility company was liable for the damages. The liability insurance tower was exhausted. This is a typical example of a loss where liability insurance towers cover for mainly natural catastrophes and where an accumulation potential is possible.

2.4 Embedding casualty risks in the overall accumulation risk

Casualty accumulation is rarely limited solely to casualty insurance losses. All the examples referred to in this publication may have implications on other P&C lines, life/annuity products, investments and to a lesser degree, operational impacts. These enterprise-wide implications require that casualty accumulation risk is not managed within a silo. Business-unit executives should be held accountable for considering firm-wide exposures in the context of their unit's business plans, portfolios and individual account underwriting. Casualty accumulation quantification efforts should factor in all material sources of risk across all liabilities and assets.

As described later in this paper, Enterprise Risk Management (ERM) plays a critical role in identifying and quantifying firm-wide accumulation risks and concentrations. Most companies maintain separate functions and management hierarchies for different insurance businesses (eg, P&C vs. Life), business functions (eg, Asset Management vs. Underwriting), and regions. These silos are not naturally focused on accumulation and correlations outside of their remit given incentive structures and general areas of focus. The emergence of ERM functions in recent decades is evidence of financial institutions' recognition of risk correlation across disparate business units and regions, and it is ERM's remit to ensure firm-wide accumulations are well managed.

Crossing the lines of business

Casualty insurance payouts are often linked to multi-line events, and this dependence should not be underestimated. A few examples of real and potential dependencies and correlations are:

- Catastrophes involving property fire policies, marine and casualty insurance, as in the Deepwater Horizon case.
- Several very long tail lines of business, like workers' compensation in the US and motor third party in countries which compensate bodily injuries by means of period payments, are exposed to longevity risk factors, in a similar way to Life & Health (L&H) business. For example, in certain European countries, the regulator mandates the use of specific mortality tables to the capitalization of periodic payments. Changes in these actuarial assumptions occur regularly and reflect changes in assumptions that spans across to L&H products.
- Natural and man-made catastrophes result in damage to property and people. The damage is covered through workers' compensation or accident & health policies, creating cross-line accumulation.

[18] Stevens, J., & Knuesli, D. "Property Events create emerging risks for casualty insurers" Retrieved from http://www.carriermanagement.com/features/2014/05/18/123020.htm

Casualty risks are important on their own and as a first step, the exposure should be assessed on a standalone basis. However, it remains essential that the Chief Risk Officer considers the correlations and dependencies across all underwriting areas.

Accumulation with the asset side of the balance sheet

Casualty accumulation of liabilities can be correlated to risks on the asset side of the balance sheet. These correlations can manifest through mutual sensitivities to macroeconomic factors or through classic clash events.

The influence of externalities/macro-economic factors on asset prices has been studied for decades. Macroeconomic factors which adversely impact asset valuations should be analysed for correlations across all sources of risk, including casualty, as part of a strong asset liability management (ALM) program. Selected key questions for re/insurers to address are:

- Can a severe spike in general inflation impact the firm's casualty reserves and fixed income assets via rising interest rates?
- Can equity market volatility or a rise in credit spreads lead to asset devaluation in concert with an increase in D&O liability claims?
- Do recessions or periods of high unemployment have an influence on workers' compensation or other casualty line losses?
- How do changes in gross domestic product (GDP) growth influence asset classes and top-/bottom-line performance of the casualty portfolio?
- How do real estate prices influence professional liability claims?

A detailed understanding of structural drivers of asset and liability risk can enable a re/insurer to optimize its portfolio and facilitate resilience to financial crises.

In addition to macroeconomic factors, classic clash events can impact assets and casualty liabilities simultaneously. As referenced earlier, the Deepwater Horizon event caused clash across a variety of insurance contracts. Had the event been severe enough to result in a BP default, the losses could have also crept into the asset portfolio via corporate bonds, equity, or other credit exposures such as captive-fronting arrangements. Likewise, a cyber-attack could lead to financial distress in an individual firm or industry sector, causing correlated losses across assets and liabilities. Finally, a global pandemic would increase L&H and P&C insurance claims, and could also wreak havoc on the financial markets.

Re/insurers need to comprehensively analyse correlated asset and casualty risks. There are perhaps other lessons to be learnt from asset management within the casualty accumulation risk space. For example, concentration risk and diversification are concepts well-known to financial risk managers, but may not be properly deployed for casualty accumulation. Ensuring that an asset portfolio is not overly concentrated in one industry or geography can help prevent outsized losses under adverse circumstances. The same concept can be applied to casualty insurance. Firms should analyse concentrations of exposure by geography, court jurisdiction, industry sector, insurance product line, supply chains and other dimensions to provide protection against unforeseen catastrophes. Analysing risk concentrations in this manner requires significant investment in data and technology, but can yield very powerful tools with which to manage casualty accumulation.

3 Assessing the potential effects of uncontrolled casualty accumulation

The modelling and assessment of the casualty accumulation risk is complex and requires skills and modelling techniques that go beyond the more-established means of assessing natural catastrophe accumulation risk. In this section we set out the issues encountered when modelling extreme events in long tail business and present some ways to go forward.

3.1 Why is casualty accumulation risk more challenging to assess and model than property catastrophe accumulation risk?

Casualty accumulation risk differs from property catastrophe accumulation risk for the following main reasons:

- Its underlying drivers are intrinsically different. Property catastrophe risk is mainly driven by the random occurrences of natural perils and the vulnerability of properties hit by an event. Hence an analysis of past events, an assessment of how vulnerable a property might be and also of the associated costs of repair allow the formulation of probabilistic laws for property catastrophe losses in the future.
  - Natural catastrophe property risks are fundamentally governed by physical laws. Casualty accumulation risk, on the other hand, is linked to human behaviour, the political, legal and economic environment, and social standards. Casualty lines are also usually characterized by a far higher legal risk (eg, stacking or date of loss or applicability of exclusions). As a result, the risk is constantly evolving. Because of its changing nature, the assessment of casualty accumulation risk is difficult and more subjective. Lessons from the past are less directly applicable to modelling the future than in natural catastrophe risk.
  - As the past may be considered a partial indicator of the future, assessing the plausibility of a specific type of casualty accumulation occurring in the future also relies on expert judgment. It requires asking questions such as:
    - What could be the next products/substances to harm the environment or humans?
    - What is the likelihood or plausibility of these products/substances resulting in mass litigation?
    - Which policies and particular lines of business of an insurance portfolio could be exposed in such a scenario, and to what extent?
  - Furthermore it requires knowing how different industries are connected, inasmuch as a court ruling resulting in a mass litigation could potentially have an impact throughout the value creation chain / lifecycle of an allegedly harmful product or substance. Understanding the types of trading connections through which clients in an insurance portfolio do business is hence also a key aspect of assessing more fully the potential for risk accumulation.
- Casualty exclusively relates to longer-tail lines of business and it takes far longer for the risks to be identified than in the natural catastrophe space. The long-term nature also means that multiple underwriting years are likely to be affected in a severe accumulation scenario, and that portfolio steering and actions to mitigate or manage the risk take time to become effective.
- In the case of an extreme tail accumulation scenario, casualty may allow for less diversification benefits than natural catastrophe cover. Geographical diversification, a key feature of natural catastrophe risk, may not hold for casualty because the spread of an event underlying the accumulation may not be confined to a particular area. It could even have a worldwide span.
- Casualty catastrophes have a lesser impact on liquidity than property events. Extreme property events are paid out quickly and require strong liquidity.

- Under solvency regimes, property risks are mainly linked to premium charges. In casualty, the exposures are covered through the reserve risk.

In the last two decades, the re/insurance industry has focused on developing increasingly sophisticated stochastic models for property catastrophe risk. These models have traditionally focused almost exclusively on earthquakes, windstorms and cyclones hitting so-called "peak markets," in other words markets with high concentration of property assets/value and where insurance penetration is high (the US, Europe and Japan). Today a number of new risk models that cover wider geographical areas and a broader range of perils (eg, floods, tsunamis, droughts) are being developed. The strong developments in property catastrophe risk modelling has made the associated risk management easier and more systematic, and facilitated the development of concepts now familiar to every stakeholder in the re/insurance sector, such as being able to set a return period for a CAT event.

The same progress in modelling has not happened in casualty accumulation risk, even though the loss potentials could be as high as or in excess of those resulting from severe natural catastrophe events. The challenges to identifying and assessing casualty accumulation risk already discussed likely explain why this is. The current approach to modelling casualty accumulation risk is usually based on deterministic extreme-scenarios whose specifications reflect expert views on plausible tail events (eg, the new asbestos, a financial crisis like in 2008). It does not use the probabilistic dimensions common in property catastrophe modelling. Both the quality and availability of data are key aspects for the impact assessment of any casualty accumulation scenario analysis.

Impact on insurers

Accumulation management is a driver of re/insurance company profitability. The volatility of individual account-level risks tends to diversify as the size of a portfolio grows. In aggregate, accumulation events and trends drive portfolio outcomes. Uncontrolled casualty accumulation can impact re/insurers, as happened in the asbestos scenario described earlier, which resulted in a multi-decade drag on industry profitability in the US and was a capital-level event for many insurers.

The unknown quantification of accumulation risk, due to long-tail and uncertain nature of casualty can cause adverse outcomes for re/insurers in two ways:

- It can cause casualty insurers to add more cumulative risk to their portfolio each year on an occurrence policy form to finally generate potentially huge hidden accumulations.
- Lack of quantification and understanding of accumulation can also lead to missed opportunities. The re/insurance industry often reacts swiftly to issues in the public eye or that are trending in scientific literature by placing exclusions on policy forms. In certain cases, the accumulation may in fact be within the firm's risk appetite, and there may be an opportunity to write the business at the right price. But the reverse happens. For example, the liability policies for industries in which people are exposed to electro-magnetic fields (EMF), such as telecoms, often exclude this risk. Yet as of today, no causal link between bodily injuries and EMF has been proven. Rather than exclude, an insurer could develop and leverage a deeper and more accurate understanding of EMF exposure to write more telecoms business.

At moderate levels of severity, casualty accumulation events tend to result in earnings volatility. Re/insurance industry stakeholders expect a certain degree of volatility for adverse events due to the nature of the risks in a casualty insurance portfolio, so these moderate events do not have much impact in the long run. However, if an individual re/insurer has a disproportionately large share of a loss for an event relative to the rest of the market, the firm may well be subject to questions regarding risk selection and accumulation management practices.

Very severe events threaten the solvency of re/insurers with lower levels of policyholder surplus and more limited diversification across business lines. History has shown that casualty accumulation events can be large enough to cause capital-reduction level losses. For this reason, casualty accumulation management is critical for proper risk management in the eyes of all stakeholders.

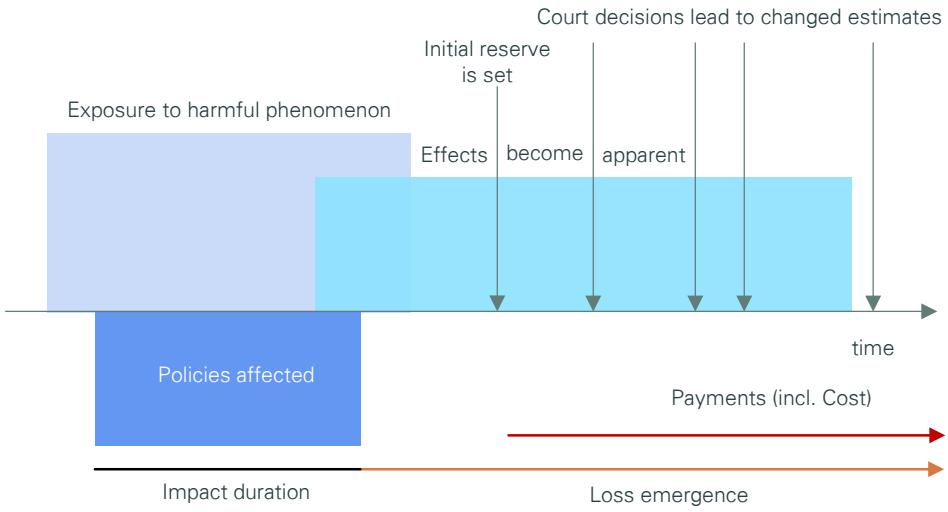
3.2 Scenario-based modelling

Casualty accumulation risk is a concern for enterprise risk management. In an environment strongly shaped by solvency frameworks and internal risk models, casualty accumulation requires a robust approach for monitoring and quantification.

The unfolding of a liability disaster

The below graph is the authors' attempt to summarise the evolution of a potential liability disaster. We shall use it to guide us through the sequence of steps to develop a quantitative risk model.

Unfolding of a liability catastrophe



Source: Swiss Re

A long period during which some harmful phenomenon might occur, followed by a number of years during which the legal system determines liability and defines compensation, is characteristic of the potential complexity of a casualty accumulation catastrophe event. Long after the original exposure, effects will become manifest and some underlying causal link will be postulated. Over time, that link will become more established, and eventually re/insurers will set an initial provision for future claims. For a major catastrophe, there will likely be still much uncertainty in the form of pessimistic estimates to counter optimistic denials of liability. A lengthy path through the courts will uncover more evidence, leading to upward (or downward) changes in ultimate estimates.

A large portion of the loss to the insurer could be the legal defence transaction costs. The case of asbestos in the US gives indication of the potential size of these: out of the total losses of USD 85bn, USD 21bn have been cited as being defence costs[19].

[19] Carroll, Stephen J. et al (2005). "Asbestos Litigation" Retrieved from http://www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG162.pdf

The scenario approach to quantification

There are typically two ways to quantify a random event. The first is based on statistical analysis of past experience. Standard actuarial reserving techniques fall into this category. This approach is relevant also for casualty accumulation risk, especially for large and mature portfolios. However, the unique nature and complexity of potential catastrophes, and the lack of history on large-scale events, limits the effectiveness of this method in quantifying accumulation exposure.

Alternatively, a scenario-based approach can accommodate different views about potential future developments. Underwriters, claims managers, lawyers and scientific experts use their knowledge and imagination to construct specific hypothetical case studies. These scenarios provide a better understanding of which components in the chain – from the initial exposure, to some harmful event, to eventual settlement – might lead to a disastrous accumulation. They can also give indication of which types of business are more dangerous, and of how expensive things may get.

The long time that an unfolding of a liability catastrophe takes exposes participants to changes in legal and societal conditions. All risk models have to cover aleatory and epistemic uncertainty. In casualty accumulation risk modelling, epistemic uncertainty is particularly relevant.

The split between these two ways of addressing the problem is not absolute. The loss experience of the past can be adapted in some way to reflect more recent developments. Similarly, some components of scenario may need to be quantified based on what has been observed before. Once a set of scenarios is established and quantified, they need to be evaluated for their relevance. However comprehensive it might seem to be, the highly unspecific nature of casualty accumulation catastrophes leads us to suspect the existence of some unexpected and negative surprise events, which could be characterised as "black swans".

Mapping scenarios to portfolio exposures

The losses that the company has to bear should a scenario materialise depend on its portfolio of re/insurance policies. To be useful, the link between scenario and policies has to be modelled.

Obviously, one could ask the experts defining the scenario to include an estimate of the company's share of the market loss into their considerations. However, a simple model based on market share makes it difficult to track the evolution of the exposure to a scenario over time, as it does not directly model the impact of the portfolio composition. We advocate the development of a clear model that maps the scenario to the underlying portfolio and exposure based on clear metrics.

Since no (quasi-)standardized exposure measure for casualty catastrophe risk exists, additional assumptions will have to be introduced to be able to construct such an exposure measure. In general, it will depend on both the scenario to be assessed and the portfolio information available. One of the challenges of a casualty catastrophe is the extent to which past underwriting years might be involved in the accumulation of losses. Finality is a concept not well defined in this context. But even besides this fundamental issue, there is the reduced availability of contract data from old years, and also the possibility that certain soft properties of contracts (like the use of certain clauses) not captured in the exposure measure underwent substantial changes.

3.3 A forward-looking approach

Limitations of current actuarial techniques

Liability exposure is a moving target. Risks are characterized by extremely heterogeneous exposures, high uncertainty and a vast array of risk drivers. Changes in local legislation, technological advances and societal trends such as urbanization, can fundamentally alter the risk

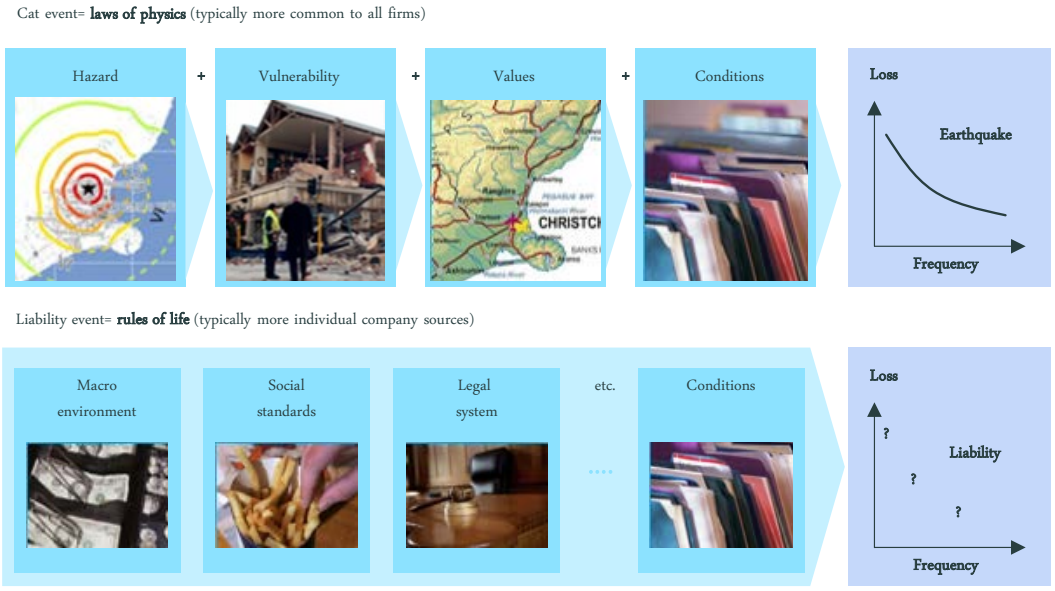
landscape, and have to be taken into account where historical data is available. For other casualty lines, mostly motor, more data is available but the risk of change remains.

Current predictive modelling techniques address this problem only partially as their structure is necessarily constrained. For example, they can quantify the impact of changes to the levels of certain variables on a loss frequency basis. But they fail to cope where societal trends alter the relationship between dependent and independent variables. In using exposure to predict loss directly, traditional actuarial and predictive modelling techniques fail to fully utilize the information of the loss-generating process. Differently put, they lack insight into the cause-effect chain from exposure to loss.

Studying loss generation: from natural catastrophe modelling to liability exposures

The systematic integration of the cause-effect chain characterises the new era of natural catastrophe modelling. It has allowed insurers to evaluate these risks with greater precision, transfer findings from data-rich geographies to others with more sparse empirics, and to improve models continuously as new events change and enhance understanding of loss-generating dynamics. Whereas the loss- generating process for natural catastrophes such as an earthquake can be defined in a relatively contained manner, for liability events the influencing factors – or risk drivers – affecting loss frequency and severity are less distinct, more numerous and, consequently, less-easily defined.

Risk Drivers in Property vs Casualty



Source: Swiss Re

While the challenge is substantial, given their global perspective re/insurers are well-positioned to gain insight into the drivers of liability risk and to utilize their data sources, and also their expert resources to identify and monitor relevant dynamics. Modelling the cause-effect chain and its driving properties overcomes the direct dependency of predictive models on the availability of big data sets, and also their limitations in the face of a changing risk landscape. These forward-looking models (FLMs) often use a scenario-based approach, and their structural form allows for more complex relationships between observable risk drivers and loss.

Parameterization of FLMs is a difficult task as the number of parameters is high and not all can be assessed based purely on data, either because data is not available or because the risk driver concerned such as the general level of litigiousness within a jurisdiction, escapes objective quantification. In principle, FLM could be set up in a way that each risk driver can be measured in an objective observable. However, this would require data for initial calibration beyond what re/insurers currently have at their disposal. As such, expert assessment still plays an important role in FLM parameterization.

Back-testing remains a challenge for similar reasons. FLMs can be fully back-tested and anchored in data-rich contexts (geographies, industries, severity ranges), but when transferring FLMs to a data-sparse context like in some emerging markets, there is often no historic data available for back-testing at all. For classical predictive models, this is a hard limitation. The structure of FLMs allows the incorporation of predictive modelling techniques such as generalized linear models (GLMs) where data availability allows, say to quantify the effects of some risk drivers, but to transcend their limitations. FLMs base their key value proposition on the assumption that a cause-effect chain can be established based on observations in a data-rich context and transferred to a data sparse one, and that only the risk drivers having to be re-assessed for new geographies/industries.

FLM approaches are still nascent and more years of historic data are required before their performance in adequately predicting loss frequency and severity can be judged. From a conceptual standpoint, FLM approaches provide three new areas of opportunity in risk accumulation assessment:

1. Their cause-effect approach could increase risk understanding and also help further improve visibility and awareness.
2. As both data and expert judgment are used in calibrating their parameters allows for the findings of FLMs to retain validity as they are transferred from data-rich to data-sparse contexts.
3. Their higher level of structural sophistication – which, granted, poses a risk of the models becoming "black boxes" to many – allows FLMs to account for more complex trends. They can preserve their predictive power also in light of changing legal, economic, societal and technology dynamics.

Casualty is a long-term business. Once the FLM approach is developed and adapted, it should be able to decompose the time steps from the first exposure or occurrence all the way to payout patterns. It could allow the study of risk drivers working on these components which can reveal accumulation risk not only for the current underwriting year, but also from past exposures for today and in the future.

Considerations on modelling for solvency purposes

A quantitative model for casualty accumulation risk needs to be integrated in the economic one-year framework of a re/insurer's internal solvency model. Despite this one-year view, re/insurers will take into account the ultimate risk horizon when making management decisions (see chapter 4 on effective management of the casualty accumulation risk). One of the characteristics of a liability disaster is its gradual unfolding over a number of years. For a long time, neither a reliable estimate of ultimate claims, nor of the timing of the payout, will be available. Asbestos is an obvious reminder of how long this period of uncertainty might be. And again, it is clear that neither the initial reserve estimate, nor some individual reserve strengthening will be a good proxy for the ultimate economic impact of a liability disaster. Even before a court has established the existence of liability, market perception could severely affect a company that is deemed to be involved.

Given the large uncertainty about the casualty scenario, no re/insurer will want to abandon the one-year approach, just to be forced to introduce new unjustifiable assumptions that would be required for quantifying the contingent evolution of the catastrophe over many years. Rather, a much-

reduced simple evaluation rule that assigns an estimated economic one-year impact to the scenario will be employed. The reasoning behind such a rule will depend on the kind of scenario considered.

Solvency is determined on the legal entity level. Therefore the casualty scenario has to be evaluated jointly with all other sub-models impacting the (economic) balance sheet. In other words, re/insurers must think about whether potential dependencies with other risk categories have to be quantified and modelled.

4 Towards an effective management of the casualty accumulation risk

In the view of the authors, managing casualty accumulation risk should remain a strategic priority for every Chief Risk Officer. The impact of a mismanaged long-tail exposure can have dramatic consequences.[20] The complexity of potential scenarios and the related modelling challenges are reflected in the complexity of how to best manage the long-tail accumulation risk. In this chapter we present some key aspects of the role of the Chief Risk Officer in this respect, and provide a way forward based on increased visibility into the underlying exposures and risk metrics.

4.1 The role of Enterprise Risk Management

The Enterprise Risk Management (ERM) function in a re/insurance company articulates the firm's risk appetite and risk limits, identifies key risks (including emerging ones), quantifies/prioritises material risks, and determines strategy on mitigating actions. Strong firm-wide risk management requires an ability to continually identify and assess accumulation risks, including casualty and exposure correlations with other risk factors, such as market and credit risk or the risks posed via other Property & Casualty insurance products.

Data quality and risk identification

Identifying casualty accumulation risks can and should be approached in more than one way. A re/insurer should utilise internally and externally-focused research to identify new and emerging sources of systemic or event-based accumulation risk. At the same time, a re/insurer should organize "exposure" data across various dimensions to identify areas of key concentration which could create outsized accumulation losses. The ERM function can help coordinate the risk identification efforts across all areas of the firm, and conduct concentration/exposure analysis across both assets and liabilities.

Risk quantification / prioritization

ERM has a leading role in quantifying accumulation risks. Quantification efforts for casualty accumulation will often require the construction of non-standard models in addition to dedicated scenarios, and ERM functions are generally staffed with statistical or scenario-modelling subject matter experts who are well-positioned to lead these development efforts. As already established, casualty accumulation events are rarely isolated to casualty insurance claims. Quantification should contemplate all material sources of risk across the firm, and ERM is a natural place to ensure consideration of all the potentially correlated impacts of casualty accumulation.

Once quantified, these risks will need to be prioritized. ERM will have awareness of all of the firm's material risks across all sources. The firm's full portfolio of risks and opportunities should be weighed when considering mitigation action for casualty accumulation.

Governance

Understanding accumulation risk should manifest itself through a firm-wide governance structure. Re/insurers should establish risk committees within each business unit and at the corporate level with clear escalation thresholds for risk exposures. Risk aggregation should be a clear mandate for

[20] Standard & Poor's (June, 2013) "What May Cause Insurance Companies To Fail–And How This Influences Our Criteria" Retrieved from http://www.standardandpoors.com/spf/upload/Ratings_EMEA/2013-06-13_WhatMayCauseInsuranceCompaniesToFail.pdf

these committees to ensure that silo-based accumulations are reported and well-understood at the senior management and board levels.

Incentives

Performance incentive-setting is an important topic for casualty accumulation risk, given the long-tail nature of casualty business and the potential of organizations to inadvertently incentivise excessive risk taking. It is possible that a firm's growth strategy may directly increase accumulation risk. For example, strategies to increase capacity within individual products or for individual accounts add larger accumulation exposures to a firm's balance sheet. "Cross-selling", an industry term for seeking to sell multiple insurance products to a single client, increases the likelihood of multi-policy payouts from single events. New business growth targets can incentivize individual underwriters to maximize short-term premium growth under the veil of hidden future adverse loss ratios within casualty lines. ERM functions, human resources and senior management need to collaborate to carefully optimize a firm's incentive structure to balance risk taking with the firm's growth aspirations.

Mitigating actions

ERM would generally not be accountable for decision-making on accepting casualty accumulation risks or deciding on actions to be taken: the business owners are the decision-makers. However, ERM checks that the business decision making remains within the risk appetite parameters of the firm. Mitigating actions are discussed in greater detail in the next section.

4.2 Managing the assumed risk

This section discusses how a company can manage its assumed casualty risk. Identifying and assessing the risk are prerequisites to managing risk. Thereafter different tools can be used and actions taken to manage the risk.

Monitoring of risk exposures

The first natural tool to develop is a system of limits to ensure that exposure taken on a particular risk driver or line of business remains within pre-assigned limits. The aim here is to avoid over-concentration on a particular risk in the portfolio. For instance, casualty exposure may be limited in terms of premium volumes and/or reserve amounts to a given percentage of available capital or insured value. The design of a stochastic model may allow a system which controls exposure to casualty accumulation at a given remote return period.

Once a system of limits has been defined, exposures may be managed upward or downward to meet the assigned limit either directly through actions impacting the inward new business (underwriting) or through outward risk transfer mechanisms (ie, reinsurance and retrocession).

Management actions on underwriting

New business may be limited by imposing caps on total policies' aggregate limits. The wording of contracts (eg, on specific exclusions) may also be adjusted to ensure scope of the cover is properly understood. However, the long-term nature of casualty risk makes immediate management actions far less effective and hence portfolio steering much more complicated.

Risk transfer solutions

Generally speaking, the retrocession market for casualty risk is less developed than for property catastrophe risks. The long-term nature of casualty risk means that the buyer of cover is exposed to a higher credit risk on the risk protection provider. Indeed, a company would expect a protection provider covering long-tail adverse developments of its casualty business to be operating in good financial health throughout the duration of the retroceded portfolio, which may be several years or

even decades. All things being equal, the selection of the risk transfer counterparty is therefore more important for casualty than for a property catastrophe cover. The latter is usually set up over a one-year time horizon and renewed annually. A collateralization of the contract may be also a way to mitigate this increased counterparty risk.

In recent years, there has been a lot of focus on capital market solutions, notably Insurance-Linked Securities (ILS), given the very strong influx of alternative capital into the reinsurance and retrocession spaces. The capital has, however, remained largely confined to short-tail lines, almost exclusively property catastrophe, for two main reasons. Firstly, modelling in property ILS relies on physical external events understandable by anyone. Casualty risk, on the other hand, is more challenging to identify and assess because it is not linked to easily understandable external events. New entrants to the liability market feel less comfortable taking on this more ambiguous exposure.

Secondly, the alternative reinsurance capital providers often have to fully collateralize their maximum liability. This full funding of the contract limit is far more adequate for short-tail lines like property catastrophe, for which the collateral is unwound at the end of the year (if no event has happened). For long-tail lines, however, the collateral needs to be frozen for a long period of time. Another likely reason for the currently low observed appetite of capital markets for casualty lines is that the (modelled) profitability margins are usually much higher in property catastrophe risk.

4.3 Increasing understanding to shape the industry

Following the elaboration on how to measure and manage accumulation risk internally, this section will discuss how a better market understanding of casualty accumulation can help Chief Risk Officers do their jobs. Building greater understanding in the casualty re/insurance market will lead to better assessment and management of casualty tail risks. This will ultimately support additional risk taking, which will be necessary to keep up with technological and societal progress.

Why is increased market transparency the future?

The need can be exemplified by an example from property re/insurance: Almost 50 years ago, an earthquake in Mexico resulted in huge unexpected losses. The 1968 event demonstrated the importance of accumulation control in property portfolios. Since then the natural catastrophe market has undergone a "transparency transformation". From standardized data collection (CRESTA zones) through to the founding of vendor models (eg, RMS) to the development of alternative capital markets (ILS), re/insurers have come a long way from non-adequate accumulation monitoring to systematically publishing exposure to natural catastrophe scenarios in their annual reports.

In comparison, to date understanding in casualty has been "reactive", that is post-event, as was the case in the natural catastrophe market 50 years ago. The asbestos case is a good example: today, most firms publish the amount and movement of their asbestos reserves in their annual reports. The extent of information available in the property market does not yet exist on measures of prospective casualty accumulation potential. How to achieve a better monitoring of such future risks?

In recent years there has been an increased awareness of casualty catastrophe risks from both internal and external stakeholders. Internally, better exposure data will be crucial in supporting risk-taking activity. An increased focus on ERM will require re/insurers to better explain stakeholders the risks the firm faces, including casualty accumulation and a disclosure of tail risks. The combination of these internal and external factors will likely lead to the same process that the property market went through, making casualty tail risks more transparent and easily understood.

Internal need for better data

Casualty accumulation monitoring is essential for optimal capital allocation within a company's risk appetite, and for risk selection. The forward-looking modelling approach may be the solution to improve reporting on casualty tail risks. Yet without good quality input data, the reliability of sophisticated FLMs will be limited. To make use of FLMs to their full potential, re/insurers need to collect better, more granular and standardized data on underwritten risks.

Furthermore, due to increased interconnectivity, it is increasingly difficult to understand and quantify a re/insurance company's exposure to accumulation risk. Increased data quality can help overcome this challenge.

However, one question remains as to what data standards should be used, and what the term "better data" actually means. Creating a data warehouse for comprehensive information on every risk underwritten by the firm may be the first step towards internally available standardized data. Variables collected and stored for all liability risks could be, for instance, an insured company's size, activity by industry code (eg, NAICS, SIC), turnover, insurance limits and sub-limits, and policy exclusions or triggers. This, however only ensures internal standardization of data.

Industry data standards for measuring casualty accumulation

To cater to the potentially increased demand by external stakeholders for more disclosure and to increase efficiency, industry-wide data format standards may be required. Much like in the natural catastrophe sphere, where an unforeseen accumulation event triggered the re/insurance industry to set up the CRESTA standards, the casualty insurance industry needs to find its own CRESTA zone-type data format for coding casualty exposure information. This will enable, among other things, the measuring of accumulation potential and thereby also increase market understanding. Industry exposure data standards will help monitor accumulation risk in liability in the future, even if it is a challenge to define those standards. An industry-wide agreement will be crucial. Associations like the CRO Forum and re/insurance companies will have to work together to set the right standards.

There are well-known challenges in defining data standards for measuring casualty accumulation. Challenges previously mentioned are that casualty events are not recurring and that the exposures are more complex than in property. However, as the industry is moving towards the requirement to better-monitor accumulation, the need for standardization is increasing. Along with the internal motivations discussed above, industry data standards would benefit external stakeholders as well. The increased understanding would allow for industry-wide comparisons, development of models, more sophisticated scenarios and new risk-transfer markets. For instance, for insurance companies not wanting to or able to invest in developing their own models for casualty accumulation, existing vendor models could provide a less expensive solution. These models will require standardized data inputs. Also, the potential development of more efficient risk-transfer solutions in the form of long-tail ILS products calls for "CRESTA standard" data, much like on the natural catastrophe ILS market where industry triggers (PERILS) are set up based on CRESTA loss data to facilitate payouts.

Possible external demand for more information and thorough understanding

Interest from external stakeholders in casualty tail risks is increasing. With the realization of the complexity and possible downside potential of the risks, they will demand more information from re/insurers.

4.4 External stakeholders

Risk transfer market

Over the past couple of years, large insurance companies have cut back their reinsurance cessions, retaining more risks net. Along with the steady growth of accumulation risk described in Chapter 1,

growing retentions have contributed to the increased net exposure to casualty catastrophes. To manage the increased accumulation potential, insurers have to find new solutions to keep this exposure within their risk appetite limits. With better models and information, Chief Risk Officers will be able to identify the right tail risks to transfer to the reinsurance market. At the same time, in order to accept and cost for these risks, the reinsurers will require insurance companies to be transparent on the accumulation potential in their reinsured casualty portfolios.

Along with traditional reinsurance solutions, the potential development of a casualty ILS market would enable Chief Risk Officers to transfer casualty catastrophe risks more efficiently and to a wider audience. Just like in the natural catastrophe alternative risk transfer market, a higher level of information as well as advancements in understanding and modelling casualty catastrophe risks will be crucial in developing a long-tail ILS market.

Shareholders

Some measurements on catastrophe risks are widely disclosed. For natural catastrophe and Life & Health, prospective exposure measures for tail risks are published by numerous re/insurers in their annual reports. This is not yet the case for casualty, where the only measure published is often the amount and movement of asbestos reserves. This reflects on past losses, but does not give shareholders a look into potential future casualty exposures.

Comparing the amount of asbestos reserves to the impact of certain natural catastrophe scenarios shows that casualty catastrophes can influence the earnings and the balance sheet as much as some property events. And, due to their long-tail nature, the effect can be span several years or decades. It is in the best interest of shareholders to demand more information and visibility on casualty risks.

Re/insurers could also increase shareholder understanding by publishing key metrics around casualty accumulation. Some re/insurers already provide information on limits on total premium deployed to long-tail exposures. Others disclose details on R&D activities to better assess casualty accumulation risks. And some insurers publish their reinsurance structures to show how they protect their portfolio. These are the first steps towards a comprehensive disclosure of casualty tail risks.

Rating agencies & regulators

Rating agencies tend to focus on property catastrophe exposures when measuring tail risks. Their capital models charge for exposure to specific natural catastrophe[21] scenarios but there is no such for casualty catastrophes yet. Recently, the industry has seen some rating agencies demand more information about the casualty sphere. For instance this year, for the first time, A.M. Best is asking US-based insurers to provide details of their casualty catastrophe scenarios.[22]

Insurance industry regulators require more disclosure not just for P&C but operational, investment and other risks as well. Detailed reporting requirements for internal models' risk measures are already in place but regulators will always strive to better understand risk management measures so as to improve policyholder protection. Further, although not mandated yet, the spirit of new regulations goes in the direction of more understanding on risk measures, including for casualty.

[21] Standard & Poor's capital model charges for 250-year probable maximum loss for Nat Cat but no such scenario is defined for casualty. AM Best is using a similar approach with defined return periods.

[22] Insurance ERM (2015), "A new breed of casualty cat model" Retrieved from https://www.insuranceerm.com/analysis/a-new-breed-of-casualty-cat-models.html

Casualty catastrophe losses can test the strength of a re/insurance company. Therefore, along with shareholders, rating agencies and regulators are bound to be interested in a re/insurers' exposure to accumulation risks. Coupled with the trend towards economic capital models, a requirement for full disclosure of casualty tail risks is likely to be inevitable.

5 Conclusions

In the view of the authors, one key task of the Chief Risk Officer of a re/insurance firm is to increase the understanding of casualty exposures, casualty accumulation risk and casualty catastrophic scenarios. These risks pose a real threat to the financial security of the firm since:

- In casualty in particular, past events might not be (fully) predictive of the future.
- Our fast evolving and highly connected society increases the risk of severe casualty catastrophes.
- The slow emergence of adverse scenarios potentially exposes multiple underwriting years to the same risk factor.
- Management actions are not effective immediately as most of the risk is already on the firm's books.

Casualty accumulation risk could be better assessed and monitored through the development of more sophisticated and standardized scenarios and models:

- We propose a systematic assessment by mapping catastrophic scenarios to the three classes of losses: the classic clash, the serial aggregation and the systemic risks. Such scenarios should cover well-known historical examples of casualty catastrophes, and also forward-looking scenarios (ie, those that have not yet materialized but could happen). A core responsibility of the Chief Risk Officer is to stress that future-loss scenarios could be materially different from historical ones, and that it would be a mistake to base any consideration of casualty accumulation on known losses only. Also, the impact of inter-line accumulation and of accumulation with financial market exposures should be part of the assessment.
- The quantitative modelling of the casualty accumulation risk of a portfolio has not yet reached the level of development and standardization found in the management of natural catastrophe exposure in property – examples were standardized data collection (CRESTA zones) and the founding of vendor models in the property market. Casualty accumulation models, in contrast, are mostly based on deterministic scenarios and statistical analysis of loss triangles. We reviewed some key aspects of a casualty accumulation model and note that forward-looking models could help better assess and monitor accumulation risk exposure.

A key enabler for the next generation of casualty accumulation models is not just data quantity, but also data quality and a better understanding of the data. The absence of standards on exposures demonstrates that the industry has not yet achieved a harmonized, more efficient understanding of how to better manage casualty accumulation risk. The industry should strive to improve quality and breadth of the casualty exposure information collected. It should also adopt data standards to facilitate effective and efficient management of the risk and further development of risk transfer solutions. The benefits would be great and support broader well-controlled risk taking activities and better communication to all stakeholders.

It is key for any re/insurance company to actively manage casualty accumulation risk to reduce the potential impact of casualty catastrophes. We hope that this paper will help raise awareness on this important subject and shape the industry's approach to the next generation of risk management of casualty catastrophes.

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