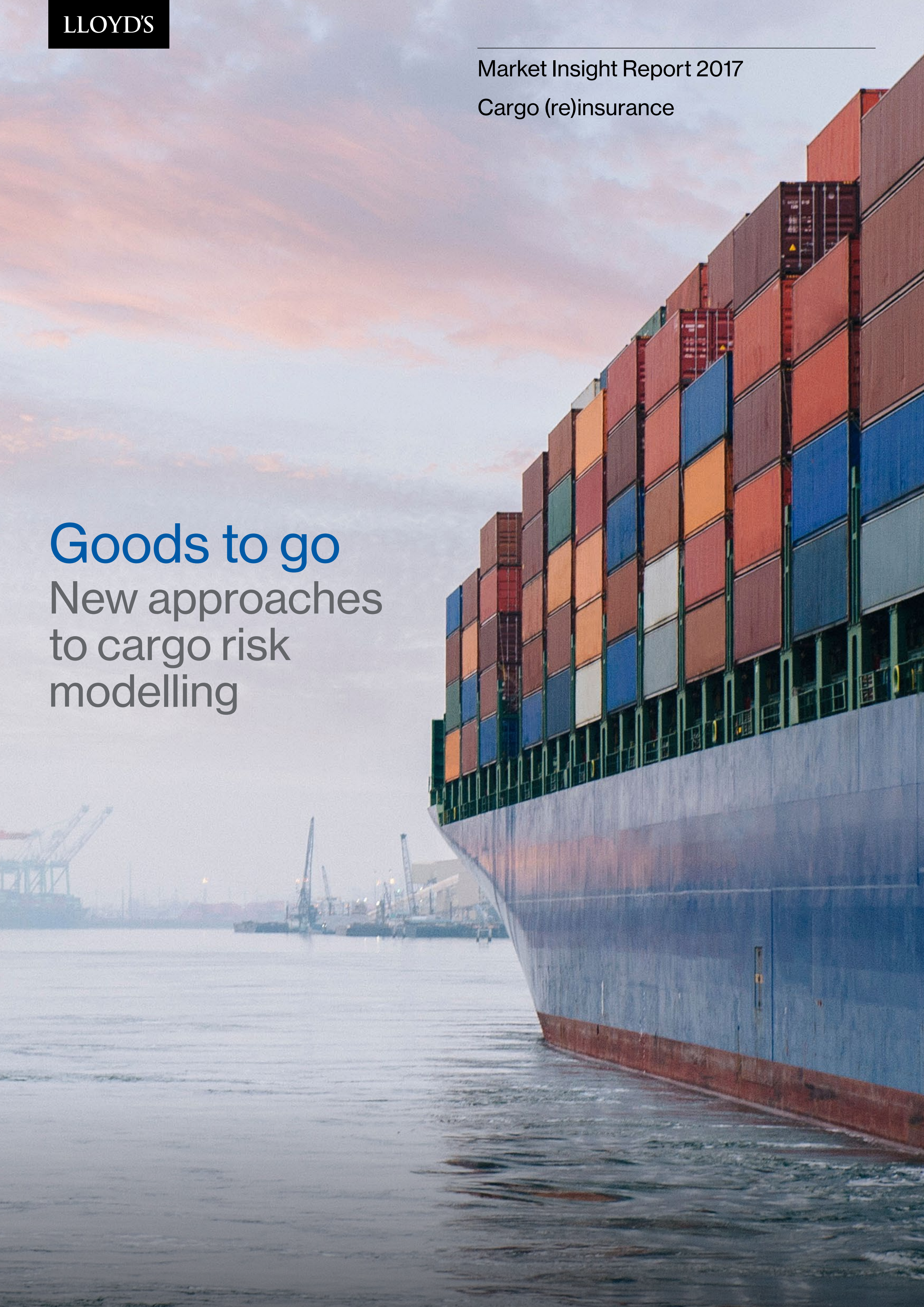
LLOYD'S

Market Insight Report 2017

Cargo (re)insurance

Goods to go

New approaches to cargo risk modelling



Disclaimer

Contents

Executive summary

This report analyses cargo insurance trends in the Lloyd's market, and uses past and present strategies for managing cargo risk accumulations to identify good practice. It aims to help underwriters develop a greater understanding of static in-the-course-of-transit cargo and in-transit cargo risk and improve their modelling of it.

Lloyd's has a long and illustrious history of maritime and cargo insurance. Lloyd's global cargo insurance business has grown significantly as international trade has increased, and in 2016 Lloyd's wrote almost £1 billion in cargo premiums. This represents 8.3% of the global cargo insurance market.

However, profitability has declined in recent years, with a combined ratio of more than 100% for the past few years of account[1]. Losses have been growing at faster rates and a number of catastrophe events have challenged the Lloyd's market's performance recently.

One reason for this decline in performance is that the severity of losses per event has increased because cargo claims inflation has increased significantly, partly due to rising values and increasing aggregations. The research suggests there is an underwriting performance gap in cargo insurance and highlights the importance of improving both static in–the-course-of-transit cargo and in-transit cargo modelling, as well as the monitoring of risk accumulations[2].

In-transit cargo modelling has been adapted from catastrophe property modelling. Although this was an improvement on what had been done before, the models do not typically include a range of factors that affect cargo risk, such as seasonality, cargo location and goods inflation.

This report highlights a number of additional factors that underwriters could take into account to improve static, in-the-course-of-transit cargo risk modelling:

- Bespoke vulnerability curves for cargo type
- Bespoke vulnerability curves for packaging
- Port and storage layout and specifications
- Vulnerability reflecting region-specific risk
- Cargo salvage potential
- Seasonality factors
- Inflation and price trends, including quantifiable socio-economic factors.

The report also identifies several projects inside and outside the insurance sector aimed at improving current practices for monitoring trade and cargo flows. One example is the use of telemetry for loss prevention purposes for inland transit. According to the company involved, this has reduced losses.

Several hurdles need to be overcome before a complete view of in-transit cargo risk can be established. However, as this report suggests, bringing together statistical forecasting methods, big data techniques, telemetry solutions and high-resolution satellite imaging, could provide underwriters with a more realistic view of in-transit cargo exposure.

Improved aggregation monitoring would not improve the economics of cargo insurance on its own. However, it could help individual insurers improve their understanding of cargo aggregation and associated risks, which could enhance risk selection and the structuring of reinsurance programmes.

Although, the benefits of such as approach are as of yet unquantified, tracking risk aggregation and cargo flows constitutes good practice and is highly recommended.

[1] IUMI statistics, Berlin conference 2015, Lloyd's.
[2] Managing risk accumulations – What are the lessons to be learned from Tianjin?, Swiss Re, February 2017

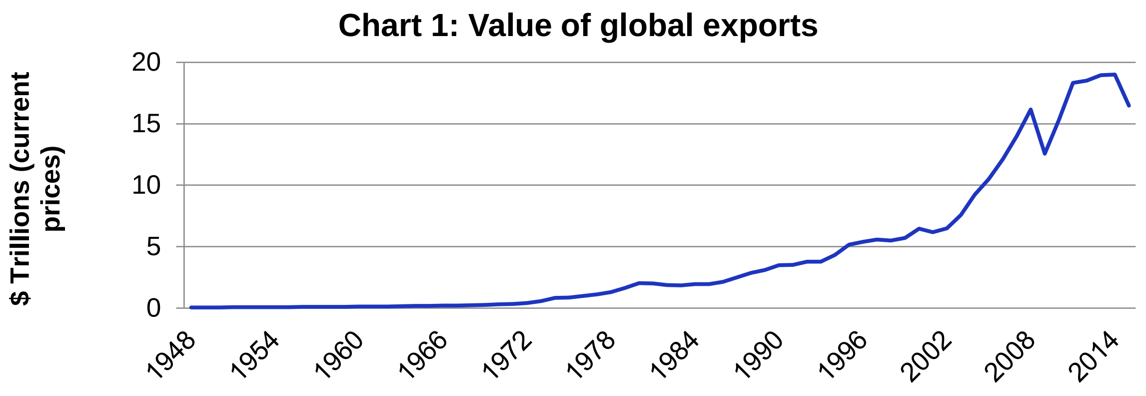
Background

1 Background

Lloyd's has underwritten specialist marine risk for almost 330 years and today is the leading provider of global maritime insurance. This colourful history has been well documented over the years.

In 1956, Malcolm Mclean invented the first modern shipping container, a development that changed the shipping industry forever (although a relatively long period of time was required for the industry to adopt and standardise containers). The introduction of containers made cargo-handling more efficient and improved economies of scale.

One of the world's largest container ships today is the MSC Oscar, built in 2015, which can hold more than 19,000 containers. To put this in perspective, 50 years ago the largest ships could only carry about 1,000 containers[3]. Globalisation, which has driven an exponential increase in the value of global exports over the past 50 years, is responsible for this increase in cargo capacity.



Source: World Trade Organisation

The growth in value of global exports can be seen in chart 1 (above). The increase in global shipping trade means that major ports now routinely handle hundreds of billon dollars' worth of cargo in a single year.

1.1 Challenges for insurers

Cargo insurers are facing multiple challenges, including underlying economic conditions, capacity growth, trends in misappropriation claims, and changing terms and conditions. The rise in exports also poses significant challenges because, as the number of containers in port and in-transit increases, so too does the concentration of cargo risk[4].

In terms of aggregation risk, cargo presents different challenges to other classes of insurance, For example, because cargo is a dynamic risk, exposed values can change significantly over time. This causes problems for cargo underwriters because unlike fixed property insurance, the value at risk can fluctuate over the policy term, depending on various factors such as trade flows (supply and demand), consumer preferences, commodity prices, supply chain movements/disruptions and seasonal trends. It is hard to track and quantify cargo risk exposure while it is on the move because reliable information is not available.

This report analyses cargo insurance trends in the Lloyd's market, and uses past and present strategies for managing cargo risk accumulations to identify good practice. It aims to help underwriters develop a greater understanding of static in-the-course-of-transit and in-transit cargo risk, and demonstrates possible methods for improving modelling.

[3] Mediterranean Shipping Company - https://www.msc.com/gbr
[4] https://www.ihs.com/products/maritime-ports-terminals-guide-2017-2018.html

Cargo at Lloyds

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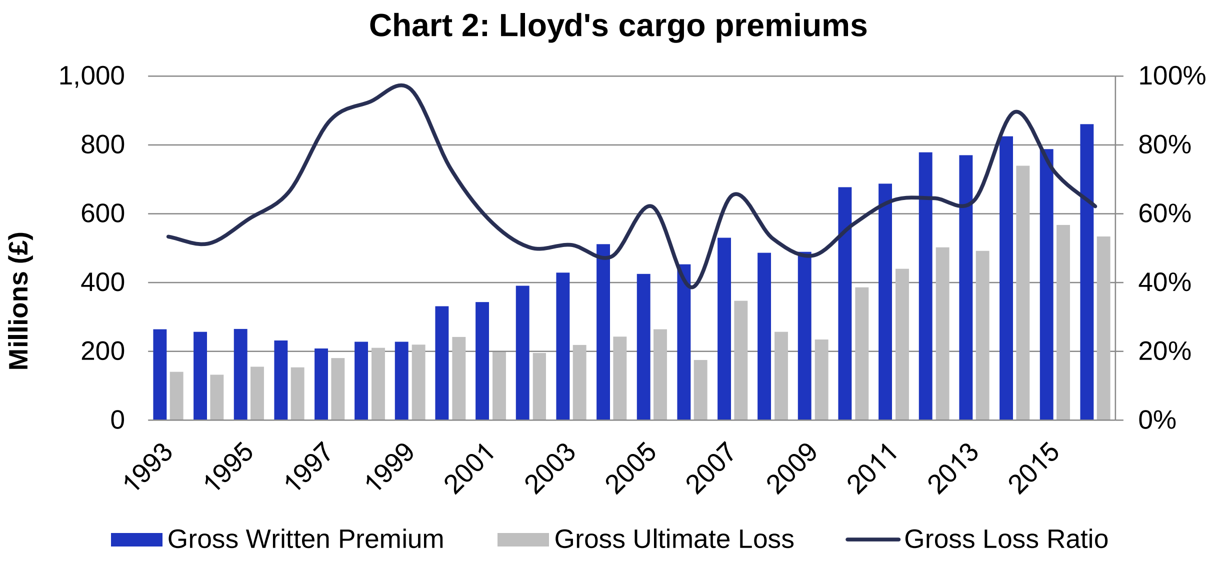
Cargo (re)insurance

2 Cargo insurance at Lloyd's

Lloyd's global cargo insurance business has grown significantly as international trade has increased. As seen in chart 2 (below), Lloyd's wrote almost £1 billion in cargo premiums in 2016. This represents 8.3% of the global cargo insurance market. However, profitability has declined in recent years, with a combined ratio of more than 100% for the past few years of account[5].

Recently, there have been a number of high-profile catastrophe events including Superstorm Sandy (natural peril), the Tianjin explosion (man-made peril), as well as other significant losses including the total loss of payload (the Amos 6 satellite) and launch vehicle (a Space X Falcon 9 rocket) that have affected cargo insurance results. The significant and increasing losses from both natural and man-made perils suggest that accurate monitoring of static in-the-course-of-transit and in-transit cargo risk constitutes good practice. These sorts of catastrophe events are not uncommon and in an environment in which cargo risk exposure is growing, alongside increasing market capacity and softening underwriting conditions, profitability in cargo insurance has decreased significantly[6]. There are likely to be further cargo insurance losses stemming from hurricane Harvey, but actual losses from this event are still unknown.

Recent large losses could still be regarded as one-offs (in an otherwise economically sustainable class of insurance) but the longer-term trends discussed in the following section could also be an indication that large losses and cargo risk aggregation have increased significantly. Losses of this magnitude are now likely to be a normal component of cargo insurance business[7].



Source: Data 1993 – 2016; 1993 – 2011 Lloyd's TPD, 2012 – 2016 Lloyd's QMR.

Analysis of the recent history of Lloyd's cargo insurance identifies the factors that affect cargo insurance and shows how risk exposures have changed over time. Growth in Lloyd's cargo premiums is closely correlated to the growth in global trade (exports). Chart 3 (see page 9) shows that top-line premium growth broadly rises and falls with trade volumes, which suggests the future growth of Lloyd's cargo insurance business is closely related to the future growth of globalisation and global trade flows.

However, since 1993, insured losses have grown at a faster rate than premium income, which indicates that overall risk exposure has increased (higher claims per unit of premium collected - see chart 5, see page 10). The data shows that it is the increased severity of large catastrophes that is driving this discrepancy between premiums and losses rather than their frequency, which has stayed broadly the same. In other words, when cargo catastrophes occur, the insurance industry is paying out more on average in claims per event than it has done in the past.

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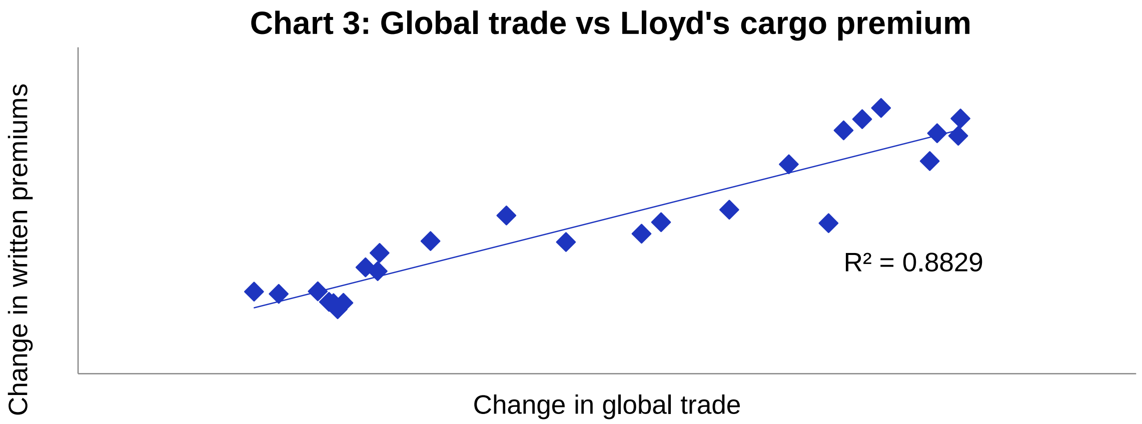
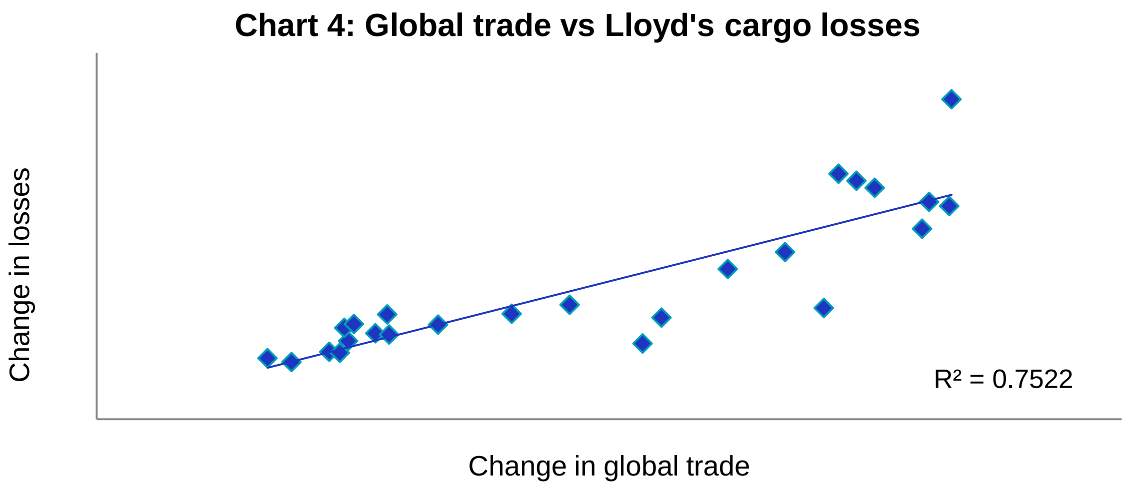
[5] IUMI statistics, Berlin conference 2015, Lloyd's.
[6] Swiss Re – Sigma 01 / 2016
[7] RMS – Quantifying & Managing Marine Cargo & Specie Cat Risk, March 2017



Source: Data 1993 – 2016; 1993 – 2011 Lloyd's TPD, 2012 – 2016 Lloyd's QMR. World Trade Organisation; global exports. Please note that the data points represent year of account and contain forecasts.

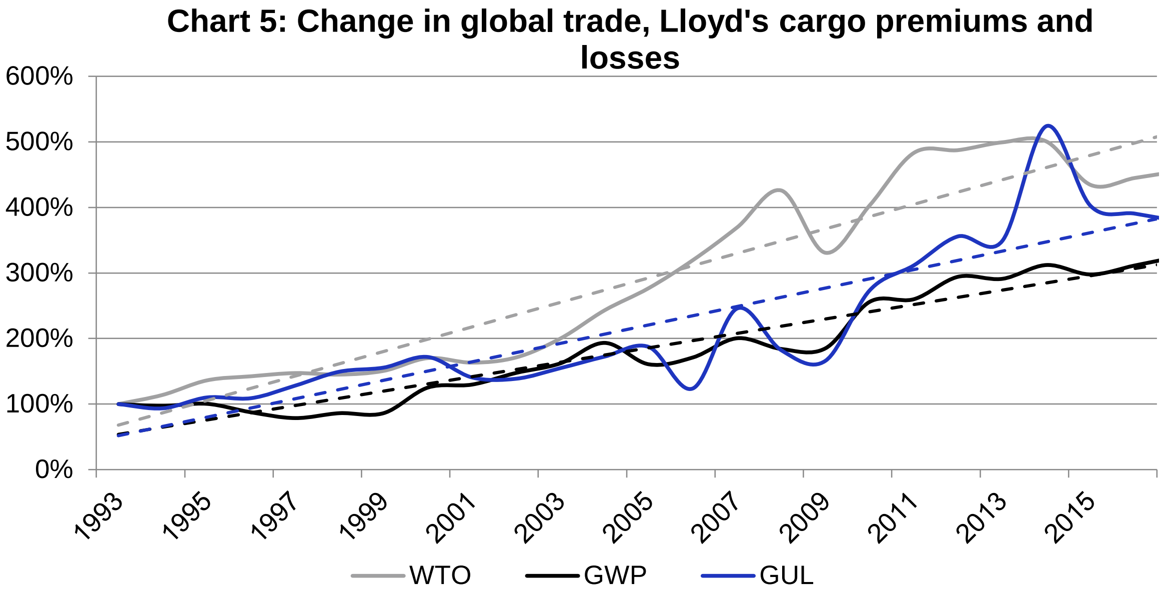
What's behind this increase in losses per event? While the rise in global trade explains the increased cost of attritional losses, large and catastrophe losses are not directly related to trade flows. Chart 4 (below) demonstrates a significant part of the change in the cargo loss variance since 1993 but not all of it (the further away from the blue line the dots are, the more volatility the class has exhibited). The reason for this is simple: the frequency with which perils occur is not related to the amount of cargo in a port or on a vessel (e.g. more ships on the sea will not create additional hurricanes). On the other hand, loss severity is likely to be higher as ports now handle cargo of higher average value than previously[8].



Source: Data 1993 – 2016; 1993 – 2011 Lloyd's TPD, 2012 – 2016 Lloyd's QMR. World Trade Organisation; global exports. Please note that the data points represent year of account and contain forecasts.

Chart 5 (see page 10) shows that insured losses have grown at a faster rate than cargo insurance premiums over the past 25 years. This loss severity (large and catastrophic losses) has picked up in recent years (as chart 7 - see page 11), which partly explains the reduction in underwriting results in the cargo classes of business.

[8] Managing risk accumulations – What are the lessons to be learned from Tianjin?, Swiss Re, February 2017

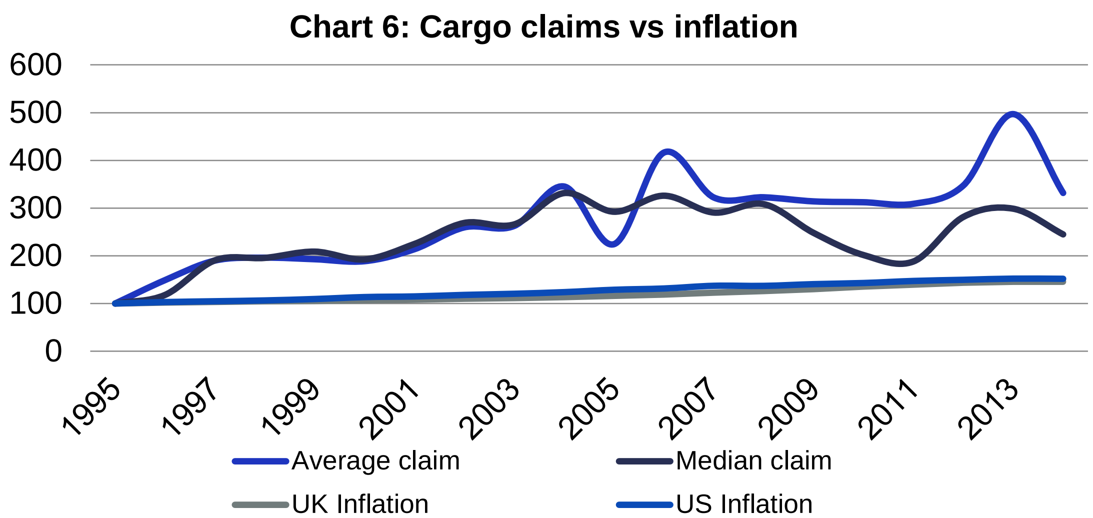


Source: Rebased to 100. Data from 1993 – 2017; 1993 – 2011 Lloyd's TPD, 2012 – 2016 Lloyd's QMR, 2017 Lloyd's SBF. World Trade Organisation; global exports. Please note that the data points represent year of account and contain forecasts

If the relationship between global trade, cargo premiums and losses remains the same in the future (e.g. there is no major change in cargo insurance economics), it is likely that as the values of insured goods increases in ports and on vessels, loss ratios will deteriorate further and the severity of large and catastrophic losses will continue to increase.

At the same time, there is no data to suggest the number of claims is increasing. This indicates that the rise in the number of total claims is due to higher cargo values and greater cargo risk exposure[9]. Nevertheless, it is worth noting that the cost of attritional claims (below £1 million) has been increasing and makes up a substantial proportion of the overall claims in the cargo class of business.

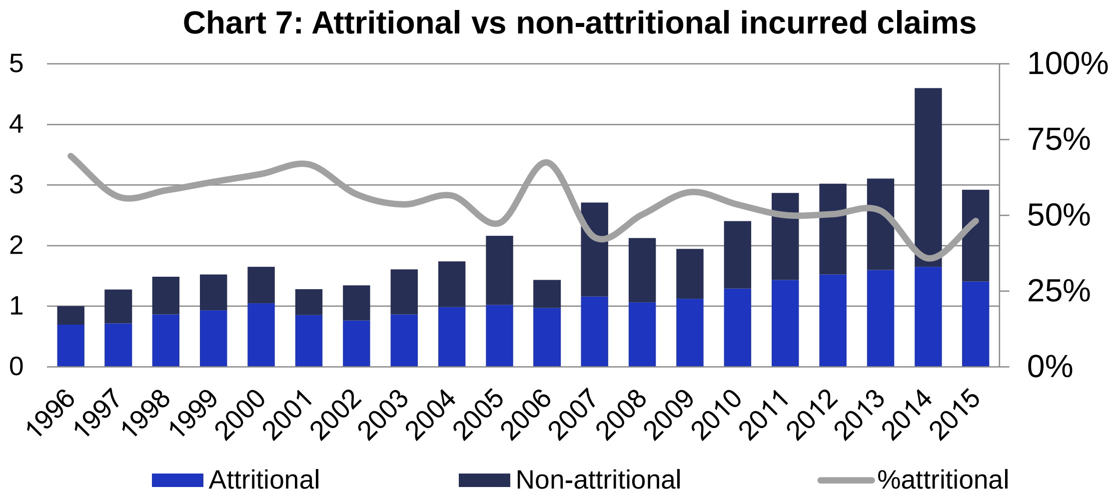
To understand how event severity has increased, it is useful to look at historical claims inflation data. As chart 6 shows (below), average and median claims have grown at a significantly faster rate than headline inflation. The growing difference between the average and the median claims in later years shows there is increasing volatility in cargo insurance. In other words when something goes wrong, the cost of incurred losses has been rising (which is partly explained by increasing risk aggregations).



Source: Data 1996 – 2016, Lloyd's claims data, rebased at 100.

Analysis of the composition of attritional versus non-attritional claims shows cargo insurance risk is increasing over time. The frequency of non-attritional claims (more than £1 million) makes up a relatively smaller proportion of the number of the total claims. However, as chart 7 (overleaf) demonstrates, the absolute value of incurred non-attritional claims is a significant and growing proportion of the total incurred claims.

[9] RMS – Marine Cargo Catastrophe Modelling, Navigating the Challenges, Charting the Opportunities, 2016



Source: Data 1996 – 2016, Lloyd's claims data, 1996 rebased at 1

In 1996, only about 25% of claims were non-attritional. Since then the proportion has grown continuously, which suggests the volatility of the class has increased, alongside the severity of large and catastrophe claims. Over the past five years, non-attritional claims have made up about 50% of the value of the incurred claims (as seen in chart 7, above). Clearly, the composition of cargo claims is complex and is affected by multiple factors (economics, terms and conditions, changing risk aggregations, etc.). Lloyd's intends to carry out further work to analyse the development of attritional and non-attritional losses over time.

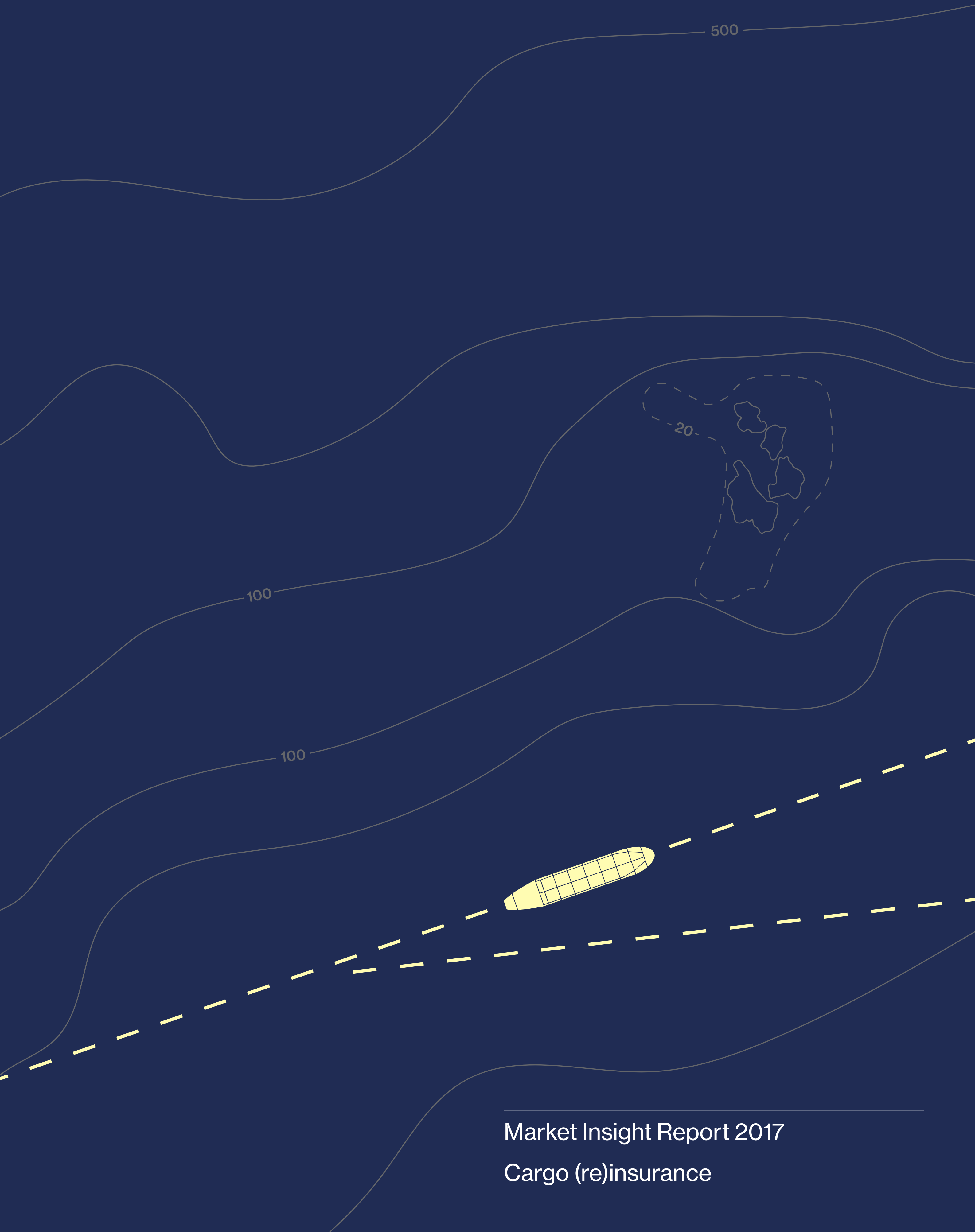
The data shows that as global trade has grown losses have increased at a faster rate than cargo insurance premiums. At the same time, the proportion of non-attritional claims has grown significantly as claims inflation has outpaced headline inflation. Cargo risk accumulation is rising as the severity of non-attritional events is increasing and research suggests that the cargo insurance industry should expect more losses of greater magnitude[10]. While the number of claims has not increased significantly, the value per claim has been and continues to do so.

Solving these issues remains challenging and there are a number of issues impacting losses in addition to rising risk aggregations. However, increasing the understanding of cargo risk and building better systems to monitor it could lead to improved risk selection and enhance underwriters' ability to structure effective reinsurance programmes.

To understand some of the challenges involved in modelling cargo aggregation risk, it is helpful to look at how modelling this risk has been done in the (relatively recent) past and what shortcomings it had.

[10] RMS – Quantifying & Managing Marine Cargo & Specie Cat Risk, March 2017

A brief history



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3 A brief history of cargo aggregation monitoring

As previously stated, managing accumulations of cargo risk, whether static in–the-course-of-transit or in-transit has been and remains challenging for underwriters, so much so that bespoke models for cargo risk have rarely been built. In the past, underwriters typically relied on simple rules of thumb to assess cargo risk. In practice this often involved an underwriter considering their customer's market share, using heuristics to build scenarios and asking questions like: What is my expected loss if a severe storm hits New York based on my market share? or What is my expected loss if there is a total loss on an "average-sized" container-vessel?[11]

According to an RMS report, cargo modelling improved when the complexity and adoption of catastrophe models for property classes of business evolved. Underwriters started to use these models for cargo risk management, using assumptions and work-arounds where the fit wasn't quite right[12].

This usually meant assigning a single value (e.g. the insured value) to a port location and subsequently running it through a property catastrophe model as if it were a warehouse and the cargo its contents. This approach had a number of drawbacks because it failed to take into account factors such as the nature of the cargo itself; storage and packaging methods; cargo vulnerability to different perils; port layout; socio-economic factors; and the seasonality of cargo flows. As these shortcomings were recognised, some relatively basic additional factors, based on intuition and rules of thumb, were included so that cargo models generated more "sensible" figures.

As the industry recognised the shortcomings of these simplistic methods, underwriters began to develop different ways of modelling and understanding cargo risk.

[11] RMS – Quantifying & Managing Marine Cargo & Specie Cat Risk, March 2017
[12] RMS – Marine Cargo Catastrophe Modelling, Navigating the Challenges, Charting the Opportunities, 2016

Understanding cargo risk

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4 Understanding cargo risk

Today's cargo risk models are typically based on established catastrophe models but are adjusted to include a number of factors specific to cargo such as vulnerability; storage and packaging; physical cargo characteristics; salvage potential; seasonality; price volatility and port characteristics.

The following section looks at these factors in more detail, using real-world examples to develop understanding of cargo risk monitoring and modelling, and to improve it.

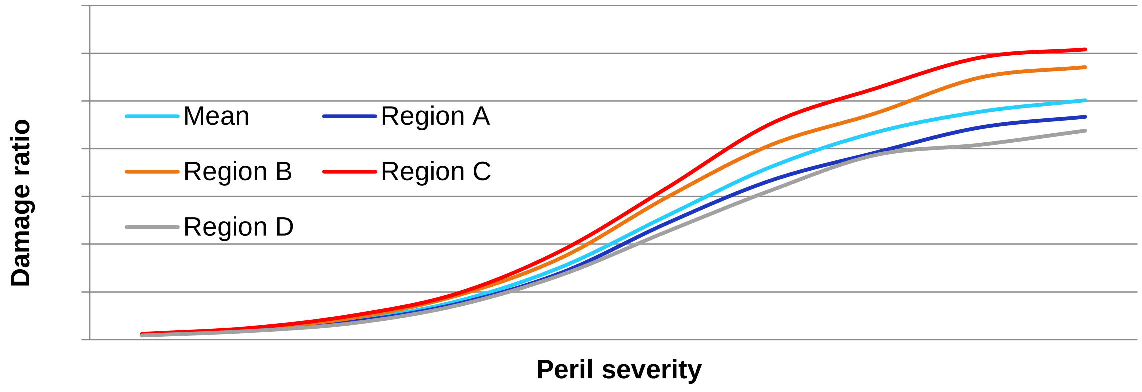
Because of the complexity of modelling in-transit cargo risk, there is unlikely to ever be a "sliver bullet" solution. However, all the methods and technology discussed in this section are currently in commercial use, either in insurance or in other sectors. This report suggests how they could be brought together to create a consistent cargo risk-aggregation modelling approach and framework.

4.1 Port characteristics

As cargo volumes have increased so have the sizes of the ports handling them. For example, the Port of Tianjin is divided into nine different zones covering an area of 260 square kilometres (the total jurisdictional area is 470 square kilometres)[13]. Given its size, while the explosion on 12 August 2015 could be felt several kilometres away and property and cargo suffered damage over an area coving a 5km radius, the majority of the port escaped undamaged. Following the explosion, a 3km exclusion zone was established but as the blast took place in a storage area, general port activity was only suspended for a couple of days[14].

Understanding the geography of a port and where and how long the cargo is stored can help refine underwriting and risk selection. For example, the Lloyd's market has historically insured commodities such as grain, oil and metals (ore)[15]. These materials are typically stored in specific locations under specific conditions and exhibit different risk characteristics compared to other types of goods such as motor vehicles. Furthermore, open-port storage poses very different risks compared to a warehouse or a grain silo. Different regions also have different storage and packaging regimes meaning that risks vary in the different ports the cargo passes through (as illustrated in figure 1, below).

Figure 1: Vulnerability per region (and port)



Source: Lloyd's, for illustrative purposes only

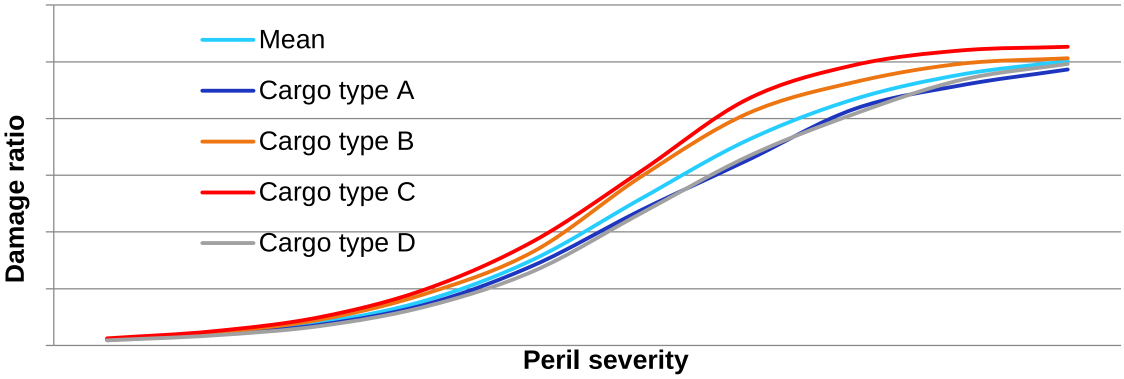
4.2 Cargo type and salvage potential

Different types of cargo have different levels of vulnerability to different perils and varying salvage potential. There is a significant difference between cargo stored in a refrigerated warehouse and metals stored in the open, for example. Different types of cargo are stored in the course of transit for different lengths of time: longer storage periods can lead to

[13] http://www.chinaports.org/info/201207/153824.htm
[14] Managing risk accumulations – What are the lessons to be learned from Tianjin?, 21 February 2017
[15] Lloyd's Underwriting Performance Review, Cargo

higher than average build-up of value at risk. The cargo's packaging can also have an impact on its vulnerability (as illustrated in figure 2, below).

Figure 2: Vulnerability per cargo type (& packaging)



Source: Lloyd's, for illustrative purposes only

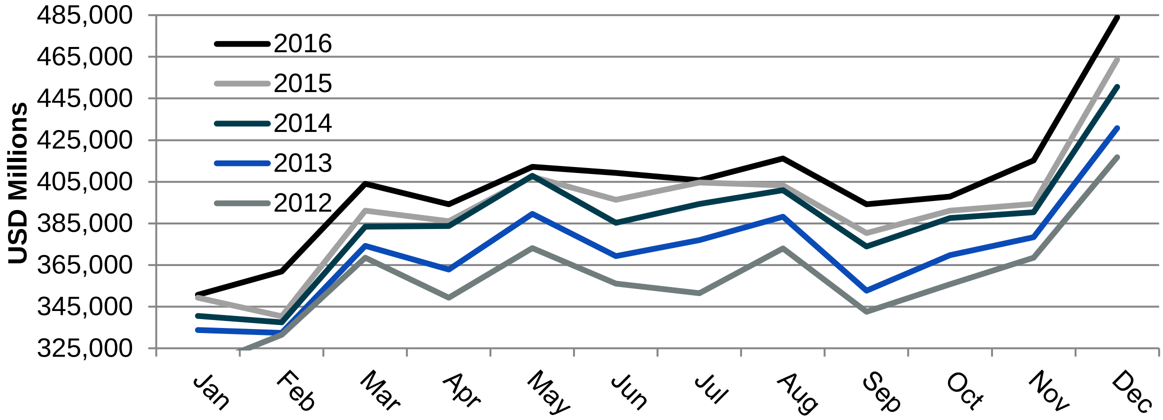
To assess this changing risk profile, vulnerability curves based on various factors including cargo type, location and storage type can be created. This data can be combined with other information such as salvage potential. This approach greatly enhances cargo catastrophe risk modelling in comparison to that based on property catastrophe exposure. While it is very data-intensive approach, it is a more accurate way to measure cargo risk accumulation.

4.3 Relating risk models to the real world

Seasonality and other trends can have a significant impact on the size and number of cargo claims. For example, ports tend to process more fashion goods before important retail seasons (e.g. in the lead up to the Christmas holidays). This means static in-the-course-of-transit, and in-transit cargo risk accumulation varies throughout the year. Exposure can also change according to fluctuations in commodity and input prices.

Retail sales show clear, consistent, seasonal patterns (see chart 8, below). For example, the largest number of sales consistently takes place in December, while smaller increases take place in the spring, summer and autumn sales. Insurers, knowing that cargo risk exposure is higher at certain times of the year, could incorporate seasonality factors, such as the build-up of goods in a warehouse, into their modelling.

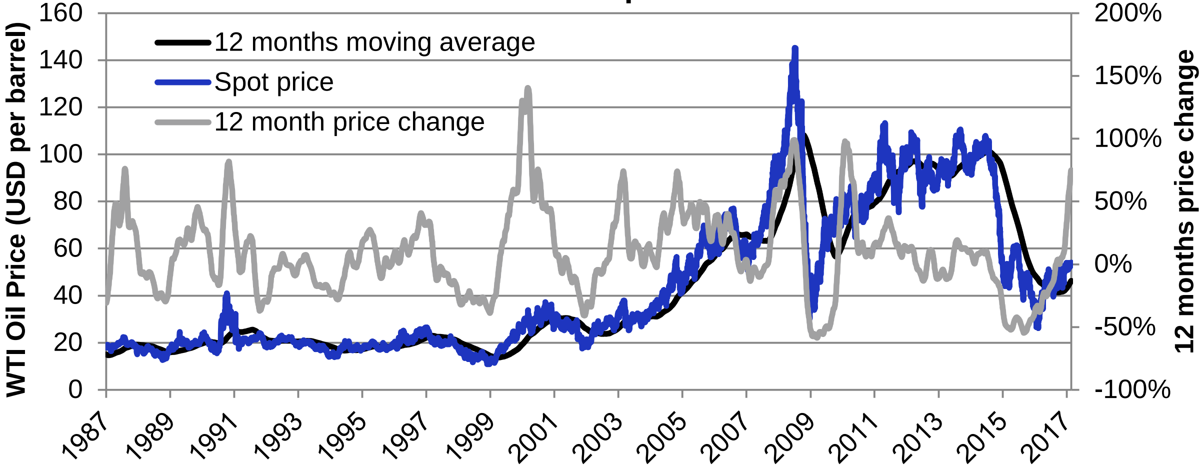
Chart 8: US retail sales



Source, US Census Bureau, retail sales, not seasonally adjusted

Fluctuating prices can also impact risk. An underwriter who insures crude oil-based commodities and who bases risk value on the 12-month average of oil prices (taken from the day of underwriting the risk) may find the value of insured cargo fluctuates significantly over the year. Commodity prices are notoriously volatile; for example, since 1987, the annual oil price change has been greater than 50% in many instances (as seen in chart 9, below).

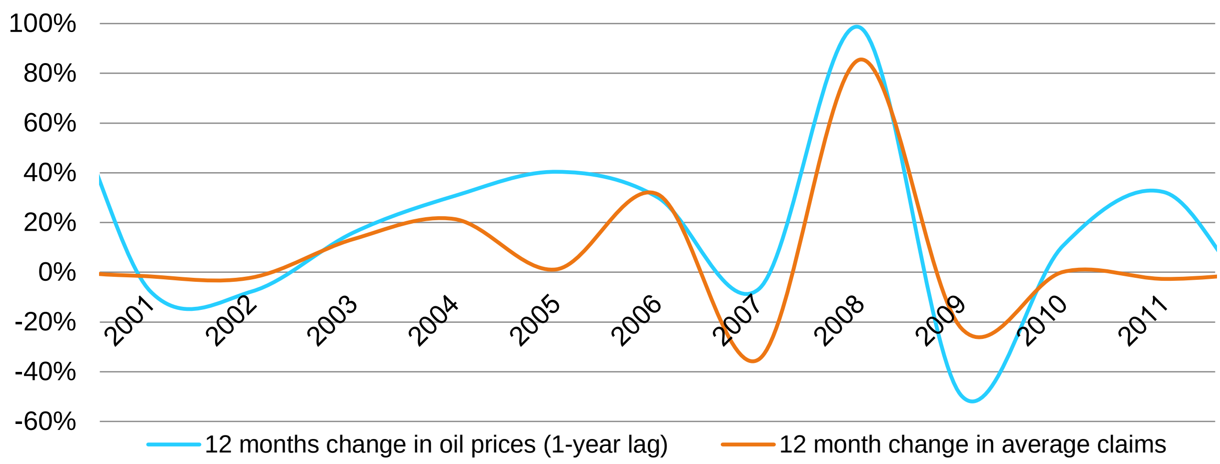
Chart 9: Oil prices



Source: Federal Reserve Bank of St. Louis

Certain other commodities (such as grain and metal) exhibit equal or greater price volatility, and it is clear that during a cycle of rising commodity prices, claims may be significantly higher compared to those when the prices were lower at the time the policy was written. Monitoring the seasonal effects and changes in the underlying value of cargo could provide a more accurate view of how cargo risk exposure changes over time. Incorporating additional discriminating and seasonality factors into risk models could improve underwriters' understanding of static in-the-course-of-transit and in-transit risk exposure. For example, the annual change in oil prices is closely correlated to the annual change in Lloyd's average-sized cargo claims (see chart 10, below).

Chart 10: Change in oil prices vs change in cargo claims



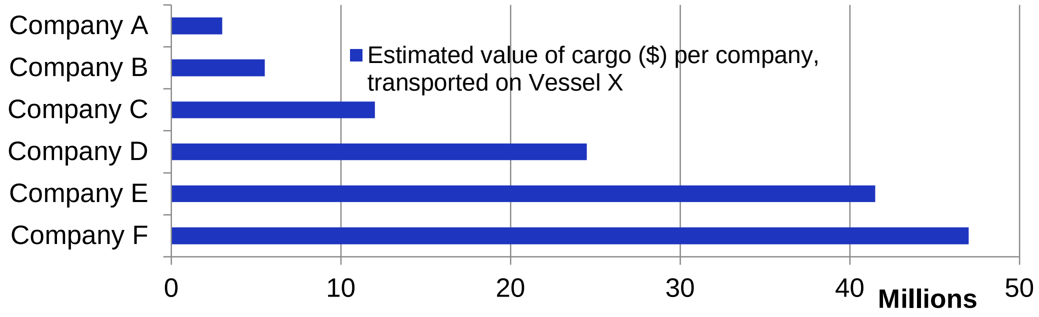
Source: Data 2001 – 2011, Lloyd's claims data and Federal Reserve Bank of St. Louis

This makes sense because the price of indemnity rises and falls with the market value of the underlying cargo (oil prices can also be seen here as a proxy for other commodities as their prices react in a similar way). By incorporating changing prices of goods in risk modelling exposure and cargo underwriting, underwriters could improve modelling accuracy. Risk managers could help address volatility in cargo claims by using broader capital markets (e.g. using futures contracts to hedge commodity price risk during the time period of a specific insurance policy).

4.4 Ways to improve in-transit cargo modelling

While in-transit cargo is more difficult to track than static cargo, improvements in big data and machine-learning mean it is possible to move towards a more comprehensive view of cargo risk accumulation per vessel. By mapping shipping companies with fleet types, capacity, contracts, seasonal effects and historical patterns it is possible to establish a more granular approach to estimating risk exposure on one or a number of vessels (as well as mapping vessels' locations in real-time). For example, the chart below shows the expected values of goods on a specific ship (Vessel X) belonging to Company A and Company B, which are $3 million and $5.5 million respectively (and so forth) as illustrated in figure 3.

Figure 3: Average value per company onboard vessel



Source: Lloyd's, for illustrative purposes only

This approach (which a few technology companies have developed, mainly for supply-chain management purposes) relies on knowing what goods from which company have been shipped by which vessel owned by which operator in the past. It does not provide an accurate real-time or forward-looking measure of risk exposure. However, it does improve understanding of in-transit cargo risk compared to an approach that assumes a "market share of market share" of each vessel (e.g. when an underwriter assumes a 1% loss after an incident because they have a 10% share of global cargo insurance and the companies they insure make up 10% of the insured value on a vessel) when estimating potential losses after an event. Having a clearer picture of where the cargo is on its journey also opens up ways to construct relatively robust scenario-based stress-tests (but still on a deterministic basis). Having a better understanding of the value of goods insured on a specific vessel can be used with more forward-looking data to generate more realistic expected loss scenarios and distribution[16].

4.5 How telemetry can help reduce losses

Currently, the best way of finding out where goods are in the world at any point in time would be by using telemetry or by recording and sending data remotely (e.g. using containers that can send their location continuously via a GPS signal). If each container could transmit its location it would allow its position to be mapped along with its content (recorded at the time it was loaded). This would mean that risk exposure within containers could be (almost) perfectly monitored in real time.

There are a number of challenges involved in adopting this technology. The first is cost. Estimates of the numbers of containers vary but one source puts the number at 23 million containers in service globally, with a further six million new containers waiting to go into service, giving a total of 29 million active units[17] (in addition there are 14 million ex-service shipping containers). A GPS tracking unit costs about $30 (2017 retail price), including simple tracking software. This means the cost of retrofitting all containers in service with telemetry devices is close to $1 billion (this does not include the cost of installing or maintaining the devices). Furthermore, systems and administration support (the content of each container would need to be properly recorded when it is loaded) would further increase costs.

Clearly, telemetry could be of benefit to underwriters and exposure managers to help understand and price in-transit cargo risk. However, it isn't clear how security and data-sharing would work and few serious attempts have been made to install telemetry in shipping containers on a large scale (refrigerated containers containing high-value items such as pharmaceuticals are often equipped with telemetry).

That said there are examples of insurers who have implemented telemetry solutions for certain lines of cargo business. One example is in marine transit insurance. Some insurers, working with the insureds' logistics teams (they identified the

[16] Managing risk accumulations – What are the lessons to be learned from Tianjin?, Swiss Re, February 2017
[17] Budgetshippingcontainers.co.uk, How many Shipping Containers are there in the World?, 1 March 2016

insureds with the highest frequency and severity of cargo losses and approached them first), have installed telemetry in lorries for about $60 per device and provide a complete back-office vehicle location monitoring service. .

The back-office function reroutes lorries away from dangerous roads. Should a lorry deviate from the expected route, stop unexpectedly or disappear from the monitoring system, a set of pre-determined actions are taken to reduce the risk of an insurance loss.

These steps typically involve getting in touch with the insured's logistics team, contacting the driver, and notifying their claims team as well as the local police force. The system is designed to trigger on a set of specific conditions, which means a relatively small back-office team can monitor a large vehicle fleet. The insurer can also potentially integrate their telemetry data with the insured's supply chain management processes (see photograph below), offering value-add to clients looking to minimise supply-chain disruption.

Initial data indicates that where telemetry is used[18] insurers' post-loss recovery rates have increased and overall losses have fallen notably for their marine transit insurance as it has also helped to reduce hi-jacking and theft. While telemetry does not necessarily represent a solution to aggregation issues, it can be used with other solutions to track insured goods as they move along the supply chain.

4.6 Tracking cargo through the supply chain

Over the past decade supply chain management has seen significant technological advances. Large corporations typically manage highly complex supply chains and use (almost) real-time information to track disruptions, delays and other issues[19]. Several of these companies use advanced software to not only track but also to reroute and manage shipments to manage supply routes and actively reduce business risks.

Strong integration between supply chain management, improved resilience and enhanced insurance solutions (with the addition of telemetry where possible) are all needed to make improvements to monitoring cargo in transit. A significant degree of co-operation and standardisation of systems between insureds, insurers and reinsurers is required to accomplish this. Given that it took the industry around 20 years to agree the standard size of a container, this task could be challenging. However, certain industries have made significantly more progress than the insurance industry to solve the conundrum of monitoring in-transit cargo.

Lessons can be learnt from other sectors. The investment management and hedge-fund sectors have been using big data analytics and machine learning to track historical movements and footfall at places such as shopping malls and convenience stores for a while now. They overlay this information with satellite imagery to predict future cargo flows. There are examples of investment companies that have already built and implemented technology to monitor real-time movements of ships that use data generated by satellite technology and past-trade patterns (using machine-learning) to predict movements of ships, commodities and other cargo types (they typically use this data for trading purposes)[20]. For example, even if it is not known where a vessel is travelling to when it is leaving port, by following it on daily satellite images, it becomes relatively easy to forecast where the vessel is heading (or at least narrowing it down to a number of possible destinations) a few days into its journey.

Even something as straightforward as Google Earth (which has not been designed for this purpose) allows the viewer to note the build-up of cars (short-term storage becoming long-term storage) and movement of goods in the Port of Tianjin in the period leading up to the 2015 explosion. The image below shows the site of the explosion in the period leading up to the blast. From the images, one can see a large number of cars and containers (and an increasing numbers of cars being stored at the site as the time of the explosion approaches).

[18] How Telematics helped ICICI Lombard reduce marine cargo loss by 40%, http://cio.economictimes.indiatimes.com/news/case-studies/how-telematics-helped-icici-lombard-reduce-marine-cargo-loss-by-40/49071332
[19] DHL, Resilience 360, https://resilience360.com
[20] CargoMetrics Cracks the Code on Shipping Data, http://www.institutionalinvestor.com/article/3526270/asset-management-hedge-funds-and-alternatives/cargometrics-cracks-the-code-on-shipping-data.html?ArticleId=3526270&p=2#.WPh5a00zWUk

Source: Google Earth 25 May 2015.

After the explosion, this relatively low-resolution image shows the destruction of the area where the cars were stored. Images with significantly higher resolution can be acquired from specialist companies that often include machine-learning techniques and crowdsourcing elements to derive additional data from the images (e.g. they automatically count the number of cars, types of cars, containers etc. in a port on a regular basis). Clearly, for this type of data to be useful, relatively high resolution imaging would need to be available (higher than that of Google Earth). At present images with a resolution of up to 31 cm[21] can be acquired, and satellite imaging technology is improving rapidly alongside the machine-learning techniques used to generate data from the images[22].

Source: Google Earth, 13 August 2015

Overlaying forward-looking data of ship movements with accurate cargo insured value estimates per company per vessel would not offer telemetry-level precision when monitoring and calculating expected and post-event losses. This data can be augmented with socio-economic information to improve underwriters' understanding of how risk exposures are

[21] which is high enough resolution to be able to separate between different types of motor vehicles
[22] Satellite Imaging Corporation, Worldwide-3, https://www.satimagingcorp.com/satellite-sensors/worldview-3/

changing over time. The research carried out for this report identified one broking company that uses satellite imagery, social media and other non-traditional data sources to augment its understanding of cargo, supply-chains and vessel movements. The benefits of using such a system are unknown but it would be an effective aid in monitoring aggregation risks.

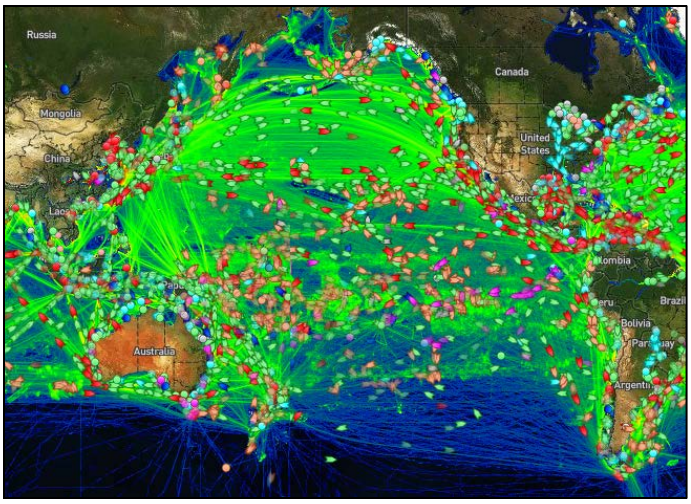
The benefits of such an approach are illustrated by the following example. The majority of the losses caused by the Port of Tianjin explosion were related to the number of unsold high-end, imported cars that were destroyed in the explosion. Data from the China Association of Automobile manufacturers[23], published well in advance of the Tianjin catastrophe, showed that imported car sales were slowing (at a higher rate than imports) and that Chinese-manufactured cars were gaining market share domestically. Any insurer involved in the automobile insurance market could have used this information to infer that unsold but imported cars (cars increase their insured value after they pass through Chinese customs) were in storage and that the cargo risk aggregation was increasing as a result.

Implementing a solution using big data and machine-learning techniques, satellite-generated data, GPS ship tracking and systematic socio-economic risk analysis is costly. However, the investment management firms already using these techniques do not employ hundreds of people equipped with expensive hardware; in fact staff numbers are in the tens and they tend to use cloud-based (pay as you go) computer technology to run their operations. As a result, their annual costs are significantly lower than if they had to buy the hardware. It's easy to expand operations as cloud services can also be easily scaled if/as the complexity of the models grows.[24]

4.7 Potential ways to improve in-transit cargo modelling

Highly accurate in-transit cargo modelling is likely to remain elusive until a viable telemetry solution for seaborne as well as land-borne cargo is adopted. In the meantime, underwriters could generate a more realistic picture of in-transit cargo risk and aggregation by combining catastrophe models with a better understanding of a vessel's insured cargo and its forecasted location.

Using an enhanced understanding of future ship movements generated by satellite imagery, augmented by conventional forecasting techniques based on ships' past movements can generate a forward-looking view of where vessels are likely to be in the future (e.g. over a one-year period). This data can be overlaid with a forward-looking view of what type of cargo (owned by which company) the ship is carrying (see figure 3, page 18). This forecast of forward-looking ship-traffic, including cargo, could resemble the image below. An image like this could show ships' journeys and a forecast of the insured cargo they are carrying, which would provide a more accurate picture of in-transit cargo accumulation.

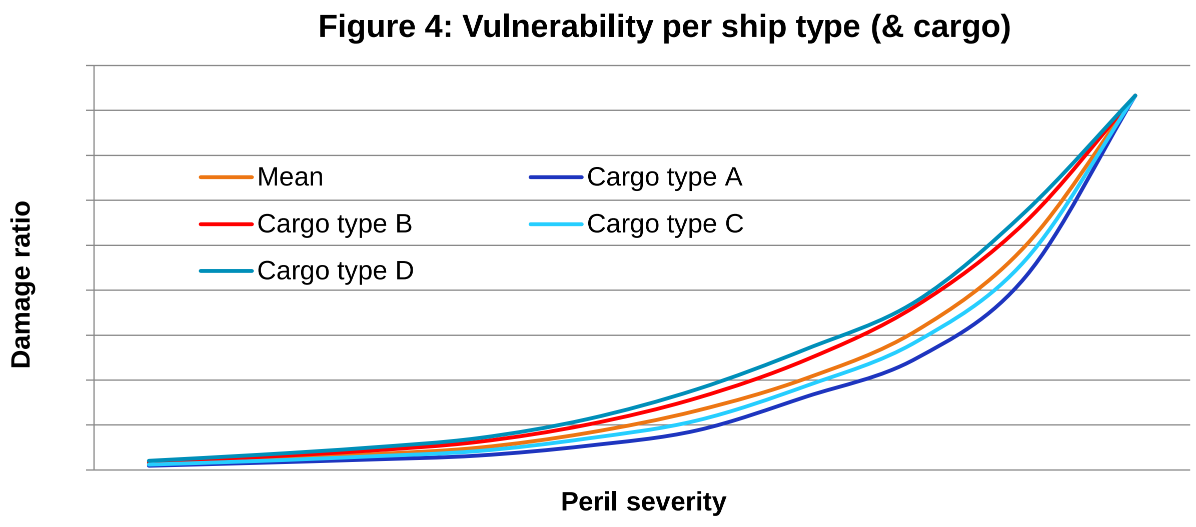


Source: Marinetraffic.com

Specific vulnerability curves would be needed for ship types, specific cargo types and packaging, as in-transit cargo risk is likely to change depending on when it's on a ship, when it is stored in a port and different weather conditions (as per figure 1 and 2 on page 15 and 16). However, the modelling principles would be much the same as those for conventional

[23] China Association of Automobile Manufacturing, http://www.caam.org.cn/AutomotivesStatistics/20150720/1605165994.html
[24] CargoMetrics Cracks the Code on Shipping Data, http://www.institutionalinvestor.com/article/3526270/asset-management-hedge-funds-and-alternatives/cargometrics-cracks-the-code-on-shipping-data.html?ArticleId=3526270&p=2#.WPh5a00zWUk

catastrophe modelling. A set of vulnerability curves per ship type, per cargo type and packaging could look something like figure 4 (below).



Source: Lloyd's, for illustrative purposes only

There are a number of quirks to take into account when modelling in-transit cargo (even if the ship's forward-looking plan is known). For example, during large storms such as Superstorm Sandy, ships are often ordered to change course to try to avoid the bad weather. This means that even if a ship's location is known as a storm approaches, it may change. This means that, assuming the storm is modelled as having a normal footprint (using conventional catastrophe models), the concentration of ships and cargo is likely to decrease in the areas where the storm is the most intense (unlike fixed property assets).

There are several drawbacks to this type of cargo catastrophe model. These include large data requirements, residual uncertainty in insured values, challenges in developing technological solutions to track ship movements and costs. Furthermore, a realistic cargo catastrophe model covering in-transit as well as static in-the-course-of-transit cargo would suffer from the added uncertainty of model miss (when modelled outcomes are significantly different from actual outcomes), not only in respect of the value of vessels' cargo but also the risk of incorrectly predicting the future position of vessels and the uncertainty associated with the modelling of the peril itself.

The future of cargo modelling

Market Insight Report 2017

Cargo (re)insurance

5 The future of cargo risk modelling

To justify the cost and effort of developing a model such as the one outlined in this report, insurers would have to see tangible benefits. Herein lies the problem: without a model to test, it's hard to demonstrate the benefits of this new approach. As mentioned, there are multiple challenges facing cargo insurers and increasing the understanding of risk aggregation alone would not improve the economics of cargo insurance. Despite this, there are a number of arguments that support the investment case, and aggregation monitoring is recommended by some insurers[25].

First, just because the benefits are unquantified today, doesn't mean the work shouldn't be done. As explained in Lloyd's recent report, The Seven Ages of Cat, little or no property excess-of-loss underwriting is done today without consulting a sophisticated model. Yet at the time these models were first developed 25 years ago, their benefits were not apparent either.

Second, cargo as a class of insurance has seen decreasing profitability for a number of years. Insurers cannot rely on the changing economic conditions to restore their profitability and maintain their competitive advantage in a commercial space in which other companies are looking to innovate and disrupt the current marketplace. Both traditional participants (such as brokers) and disruptors (technology firms, asset management companies, etc.) are already trying to disrupt the shipping insurance sector and capture market share from traditional firms. Most of the technologies required to do this are not new; these companies are merely combining several existing technologies in new ways.

Improving the modelling framework in any class of insurance can help provide a better view of the underlying risk which, all else being equal, should lead to improved risk selection. In insurance and in business more generally success is not just about the "wins" but also about avoiding costly mistakes that can often be the difference between running a profitable (class of) business or not.

[25] Managing risk accumulations – What are the lessons to be learned from Tianjin?, Swiss Re, February 2017

Next steps

6 Next steps

With global trade continuing to grow, large ports and ships are routinely handling large volumes of cargo (typically with values in the billions of dollars) and aggregations are likely to have grown substantially over the past 25 years. The rise in the cost of large losses highlights that it constitutes good practice to monitor aggregations in cargo classes of insurance.

This report concludes that static in-the-course-of-transit cargo modelling could potentially be improved by incorporating the following additional factors:

- Bespoke vulnerability curves for cargo type
- Bespoke vulnerability curves for packaging
- Port and storage layout
- Vulnerability curves reflecting region-specific risk
- Cargo salvage potential
- Seasonality factors
- Inflation and price trends, including quantifiable socio-economic factors

These factors could be adapted for static in-the-course-of-transit risk modelling. As well as carrying out more realistic risk modelling, monitoring and quantification of in-transit cargo, underwriters could use other approaches to tackle the complex nature of in-transit cargo risk. There are currently several ongoing projects inside and outside the insurance sector aimed at improving current practices for monitoring trade and cargo flows.

Several hurdles need to be overcome before a complete view of in-transit cargo risk can be established. However, as this report suggests, bringing together statistical forecasting methods, big data techniques, telemetry solutions and high-resolution satellite imaging, could provide underwriters with a more realistic view of in-transit cargo exposure.

Improved aggregation monitoring would not improve the economics of cargo insurance on its own. However, it could help individual insurers improve their understanding of cargo aggregation and associated risks, which could enhance risk selection and the structuring of reinsurance programmes.

Although, the benefits of such as approach are as of yet unquantified, tracking risk aggregation and cargo flows constitutes good practice and is highly recommended.