Demystifying the origins and applications of original loss curves

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Increased limit factors (ILFs) and first loss scales are widely used for London Market insurance and reinsurance pricing. However, original loss curves can often be shrouded in mystery; they're studied in actuarial exams but, if not used in a given practice area, can be easily forgotten or just misunderstood. In this whitepaper, Shani Clarke discusses the origins of original loss curves and their practical applications in property/casualty insurance.

About the author

Shani Clarke is an Associate Actuarial Consultant for Verisk Europe. Through her role, she is working closely on external US data available for London Market syndicates.

She has a Masters' degree in Actuarial Science from the University of Leicester where her dissertation focus on the impact of the 4th Industrial Revolution on the Insurance market. Shani has nearly 10 years London Market pricing experience, starting her career at Mitsui Sumitomo. She is keen to understand how we can innovate the pricing within the London market and is passionate about enriching pricing models with good quality, robust, claims-based data.

Pricing insurance towers

Risk pricing is a unique challenge as the cost of the product isn't known at the time of sale. We're attempting to find the expected cost of claims for a particular risk, even if the risk event hasn't been historically observed. The claims themselves are random events with an uncertain frequency and severity.

In the London Market, it becomes even more challenging as pricing often involves determining the layer loss cost for risks with large limits and complex structures.

There are two types of risk pricing that can be deployed; experience rating, where the premium charged depends at least in part on the actual claims experience of the risk, and exposure rating, which is often used to complement experience rating and is used to estimate the loss cost without considering past claims experience.

Original loss curves fall into the exposure rating category and are essentially an industry benchmark used to link losses in a given layer to losses in another layer. They are particularly useful and powerful when the data is sparse or unreliable or if the business is volatile.

They also provide a consistent internal process for pricing different limits in the portfolio. The term 'Original loss curve' is rarely used in practice, with the market favouring terms such as first loss scales, exposure curves, loss elimination functions, and excess of loss scales for property business and increased limit factors (ILFs) for casualty business.

For property, the first loss scales give a proportion of the full value premium allocated below the limit, i.e., the primary layer. Excess of loss scales are similar, but they give the proportion of the premium to be allocated above the limit—so the excess layer rather than the primary.

Increased limit factors in casualty are generally given in the form of a table of multiplicative factors, which give a ratio of premium for higher limits compared to a basic limit.

Property rating

The commercial property market has been hardening, with premium rates steadily increasing since the end of 2018[1]. The risk appetite and conditions for most insurance carriers are becoming increasingly restrictive, which is likely a result of inadequate property premiums leading to significant losses, COVID-19 and the adverse 2020 FCA test case outcome for insurers*, inflationary increases on building materials, and an uptick in natural disasters.

Syndicates and other market players are actively investing in their pricing capabilities, and commercial property is a priority for many due to concerns around poor underwriting performance.

Reliable benchmarks for the loss costs and first loss scales are key to ensuring that a fair and accurate premium can be achieved across large commercial property portfolios where inadequate pricing has often been observed.

First, we will consider the theory of applying first loss scales and then follow with a worked example.

First loss scales

Property first loss scales are based on the sum insured and give the actuary or underwriter an effective method of allocating premium to higher layers of a risk. We begin by defining the relative loss cost, Y, which is X, the claim amount divided, by M, the sum insured.

$$Y = \frac{X}{M}$$

We use the relative loss cost rather than the original lost cost because using the original loss size distribution would mean that the curve will depend on the size of the risks giving rise to the claims distribution, and for each size of policy, a new curve will be required. Having a new curve for each policy size would not be practical or even feasible.

We then define the exposure curve, G(x), as:

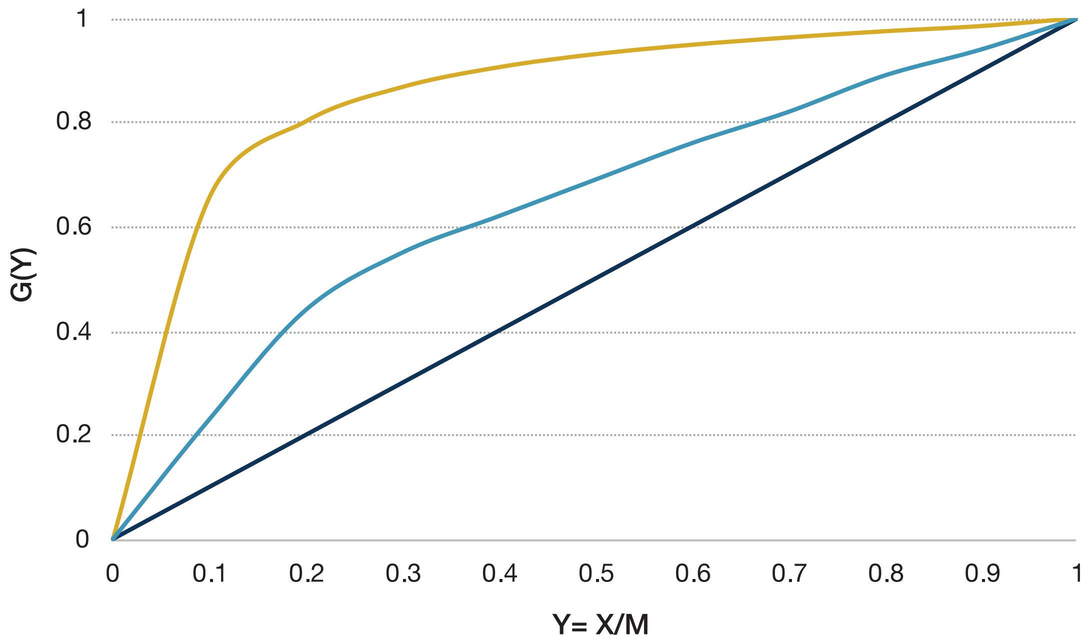
$$G(x) = \frac{LEV_X(x)}{E(X)}$$

where $LEV_X(x)$ is the limited expected value function, $E(X \Lambda\, x)$. This is the expected value of the losses, X, limited to a primary layer size of x.

The properties of the limited expected value function determine the overall concave shape of the original loss curve. As the limit increases, the LEV value increases, so the function is non-decreasing but at a decreasing rate.

* Supreme Court judgment in FCA's business interruption insurance test case. The FCA took six insurers to court on behalf of policyholders to determine whether their BI losses should be paid and the insurers substantially lost the case.

The curve G(Y) is essentially a graphical depiction of the ratio of claims costs below a given point, y, and the total claims cost. The graph below shows some example first loss curves:



The gold curve shows that a high percentage of the losses fall into a low layer. This demonstrates that there are more attritional losses than large losses, i.e., that the distribution is positively skewed. For example, the layer 0-20% of the sum insured is expected to contain 80% of the losses.

The light blue curve gets closer to the dark blue diagonal, which indicates a higher proportion of losses are large losses. This illustrates that the steepness of the curve is related to its severity.

In order to calculate the loss cost for the layer, the ground-up loss cost should be multiplied by the difference between the exposure/first loss curves evaluated at the upper and lower limit of the layer, both expressed as a proportion of the sum insured value.

C_L= Layer Loss Cost

$$C_L = C * \left\{G\left(\frac{L+D}{M}\right) - G\left(\frac{D}{M}\right)\right\}$$

C = Ground-up loss cost (for the whole sum insured) M = Risk size D = Deductible L = Layer in excess of D

Numerical example

A policy has a sum insured value of £10,000 with a risk premium of £3000.

You are about to participate in an excess policy for the £5000 xs £2000 layer..

What is the risk premium (loss cost) for the layer?

$$C_L = £3000 * \left\{G\left(\frac{7000}{10000}\right) - G\left(\frac{2000}{10000}\right)\right\}$$

$$= £3000 * \{G(0.7) - G(0.2)\}$$

$$= £3000 * (0.96 - 0.8)$$

$$= £480$$

Y	G(Y)
0%	0%
10%	66%
20%	80%
30%	87%
40%	91%
50%	93%
60%	95%
70%	96%
80%	98%
90%	99%
100%	100%

Practical considerations

There are several practical considerations that we need to be aware of when using the curves.

Relative claim size assumption: Y can be considered as independent of the size of risk. For homogenous risks, studies have shown that this assumption holds where the sum insured is a good measure of the risk size, but for a more heterogeneous portfolio, Y will be dependent on the peril.

We assume that the curves are built using appropriate and relatively homogenous data, but in order to accurately benchmark a risk or portfolio, we should consider curves for the appropriate jurisdiction, subclass, and coverages.

Perils: First loss scales can be produced by peril; however, the actuary would need to price the full value risk by peril in order to use these curves.

Inflation: If we believe that the inflation effect is uniform across all sizes of loss, then the value of Y remains unchanged as the original claim size and sum insured will increase in proportion. However, if we believe that the inflation impact is different for different sized losses, we need to understand the relative impact on different loss sizes or rework the total curves.

Inuring reinsurances: As reinsurance B acts on the net amount after A has been applied, we will need to adjust the risk profile before applying the curves.

Deductibles: Is the exposure curve built on the same basis as the risks being priced?

Property catastrophe pricing: In theory, we could use exposure curves, but they are likely to differ a lot by geography and be quite sensitive to those changes. In reality, we would use some form of proprietary software to determine the CAT loss cost, and if this wasn't available, we could use zonal aggregate exposures. Zonal aggregate exposures essentially scenario test unmodelled perils, but it has its limitations as good risks and bad risks are looked at in the aggregate, so individual risk underwriting is ignored. In practice, you wouldn't really use it on its own; you would use it to supplement or enhance your CAT modeling.

Casualty rating

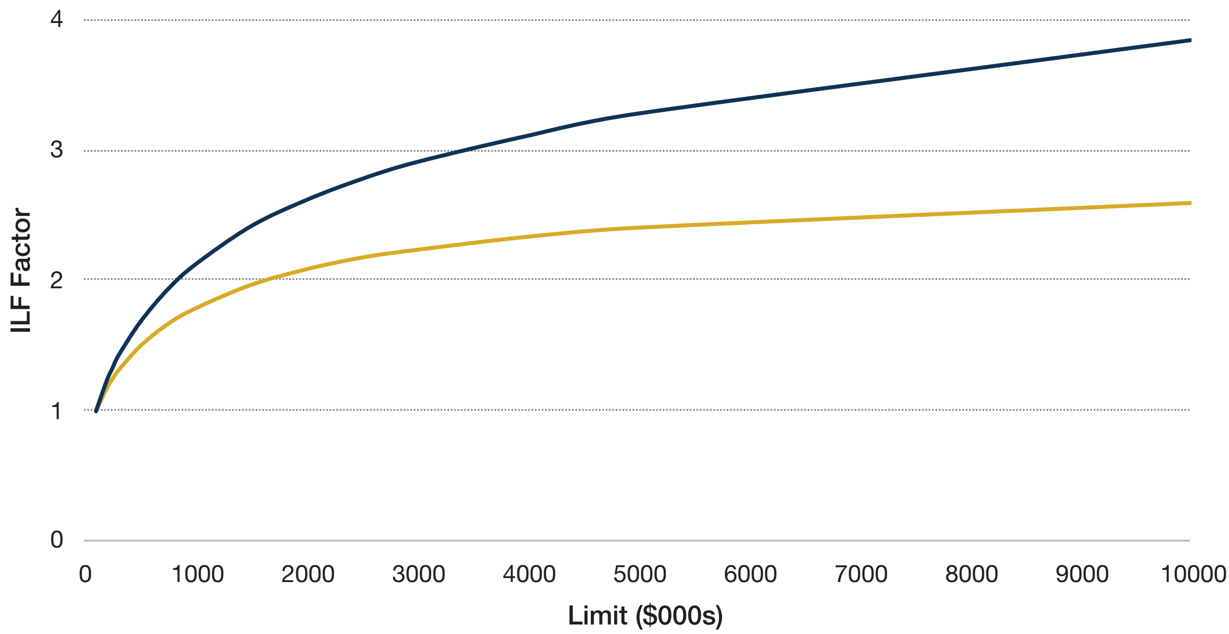
The global casualty market, too, has had its issues, particularly in 2020. Employers' liability and workers' compensation classes could be particularly impacted by the impending return to work as Covid-19 restrictions ease and the debate continues regarding the safety of employees in their workplaces.

The market has seen a sustained increase in the cost of claims mainly due to social inflation. As a response to the increasing litigiousness of the U.S. market, carriers are writing higher deductibles and limits, reducing capacity and tightening their wordings, but while this is most evident in the U.S. market, it appears to be a global trend.[2]

Unlike property rating, with liability, there's theoretically no upper limit to the liability and the limit does not provide information about the potential loss severity.

Casualty pricing differs from property rating as we don't use exposure curves. Unlike property rating, with liability, there's theoretically no upper limit to the liability and the limit does not provide information about the potential loss severity. We therefore introduce a new curve called an increased limit factor (ILF). ILFs are a ratio of the loss cost for a given limit to the loss cost for a chosen basic limit. It indicates the increase in the cost of claims with a corresponding increase in the limit.

The basic limit, b, will be chosen on the basis that there is sufficient past data to estimate the claims cost with a high degree of confidence.



The ILF curve shown above starts at 1 because this is where we have chosen the basic limit b, but for limits below b, we can have ILF factors that are less than 1.

The property curve differs as it is limited on the range 0 to 1 whereas this is not the case with liability. The ILF at level x, relative to a basic limit b, is:

$$\text{ILF(x)} = \frac{Expected\ loss\ cost\ (x)}{Expected\ loss\ cost\ (b)} = \frac{Expected\ frequency\ (x)*Expected\ severity}{Expected\ frequency\ (b)*Expected\ severity}$$

The limited expected value function also plays a vital role in the ILF curve. The curve will be concave just as the first loss scales due to the non-decreasing function increasing at a decreasing rate.

The ILF is the ratio of the limited expected value of x at a given limit and the basic limit, b.

$$\text{ILF(x)} = \frac{LEV_x(x)}{LEV_x(b)}$$

The formula for calculating the layer loss cost is the full value loss cost multiplied by the difference between the ILFs evaluated at the limit and attachment points of the policy.

$$C_D = \text{Basic Limits loss cost}$$

$$C_L = C_D * \{(ILF(L + D) \ - ILF\ (D))\}$$

There are two main assumptions made about the curve:
- The loss frequency is independent of the limit purchased
- The severity is independent of the number of losses and limit purchased

These assumptions may not hold due to deep pocket syndrome, where companies are often targeted by “no win, no fee” solicitors if they’re aware that the company has lots of cover. The company receives claims based on their ability to pay rather than the validity of a claim. Conversely, if a company has lots of insurance, it may well be that their risk management procedures are exemplary and, as a result, receive fewer claims.

Numerical example

A liability risk has the following attributes:
- No deductible
- Limit: £5m
- Loss costs up to £1m = £200K

What is the risk premium for the full limit policy?

$$\text{Risk Premium} = \text{Loss costs up to £1m} * \frac{\frac{ILF_{5m}}{ILF_{100k}}}{\frac{ILF_{1m}}{ILF_{100k}}}$$

$$= \text{Loss costs up to £1m} * \frac{ILF_{5m}}{ILF_{1m}}$$

$$= £200k * \frac{3.530}{3.357} = £214.6k$$

Limit	ILF
5,000	0.284
25,000	0.626
50,000	0.847
100,000	1.000
250,000	1.432
300,000	1.617
400,000	1.900
500,000	2.208
600,000	2.600
700,000	2.877
800,000	3.058
900,000	3.265
1,000,000	3.357
5,000,000	3.530
10,000,000	3.771

Practical considerations

Expenses: One of the most important considerations is the treatment of allocated loss adjustment expenses (ALAE). A large proportion of liability claims is the defense costs. As such, we need to understand whether ALAE can be included within the limits or in addition to the limits. We also need to be aware of whether the curves include some sort of risk load/contingency margin or are the pure indemnity.

Nature of the Limits: Are they per claim; that is, when the curve is based on amounts paid to each claimant for losses arises from one incident, or are they per occurrence, where the curves are based on the total amounts paid to all claimants from one incident?

Claims inflation: As liability claims are longer tailed than property claims, that is, they typically take longer to be reported and settled, the impact of inflation is more significant. There are three ways in which the impact of inflation can be included in the ILFs; the first and easiest way is to deflate the limits. If the curves are constructed using empirical data, the losses or the underlying distribution should be trended to reflect the assumed inflation.

Open claims: If we're constructing our own claims, we may want to remove open claims from the data as depending on where the claim sits in terms of its development, we may underestimate the final loss cost.

Sourcing original loss curves

Original loss curves, whether used for property or casualty business, are extremely useful. They provide consistent internal pricing as all risks in a portfolio will be priced using the same basis. They're particularly useful when the data is sparse, irrelevant, or not credible due to changing underlying factors. What's more, they're very simple to implement, often provided in a tabular format, and easy to explain.

However, the drawbacks include the difficultly of selecting the curves due to their availability in the market. Loss costs may also be very sensitive to changes in the selected curves, therefore care and expert judgment are required when making selections. Finally, there is often insufficient data to build the curves from empirical data.

The ideal curves are robust and reliable, based on credible claims data, but many of the most commonly used curves are either formula-driven, so parametric curves such as the MBBEFD curves or ILFs tend to have a log-normal, Pareto, power or mixed exponential distribution.

There are also a number of market curves that are available such as the ISO Curves, Swiss Re/Gasser curves, Lloyd's curves, Ludwig and Salzmann curves. However, many of the market curves have significant limitations and are based on data that's 30 years old or more. Some are based on buildings cover only (not contents or business interruption), perils may be limited to fire only, and the granularity of data may not be sufficient e.g., it doesn't vary by occupancy or size of risk. An additional issue is that most curves are based on U.S. data which may not be suitable for other jurisdictions.

The ISO Curves offer the most up-to-date, granular, and comprehensive coverage of the widely available market curves. This is available for the U.S., and recalibrated versions are available for the UK, Germany, France, the Netherlands, and Australia. In the absence of a sufficient volume of non-U.S. data to derive the curves from scratch, the U.S. curves have been recalibrated using the COPE factors (construction, occupancy, protection, and exposure) and ARM factors (amount of insurance, rebuild costs, and miscellaneous factors like social inflation, etc.). They've been validated using international data.

All Lloyd's syndicates have access to the Lloyd's ISO Portal, which acts as an interface for Verisk's data. Within the portal, there are 18 lines of business containing loss costs information, trends, increased limit factors (ILFs), as well as forms, wordings, circulars, and estimates of catastrophic insured property losses.

Sources

1. The property insurance market continues to harden in 2021, Global Risk Partners, <https://www.grpgroup.co.uk/our-broker-businesses/thinking-risk/the-property-insurance-market-continues-to-harden-in-2021/>, accessed 1st September, 2021
2. State of the Casualty Market - Q2/Q3 2021, Amwins, <https://www.amwins.com/resources-insights/article/state-of-the-casualty-market>, accessed 1st September, 2021

For more information about ISO Curves, current data sharing initiatives or any other issues discussed, please contact Shani Clarke at shani.clarke@verisk.com.

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