7.1.2 → Shock Losses

→ Overview → As mentioned in the previous section, historical losses need several adjustments before they can be used for ratemaking, including:

→ Replacing extraordinary events in the historical data w/ long term expectations

→ Adjusting losses for changes in coverage or benefits, including changes required by law

→ Developing immature losses to their ultimate settlement value

→ Trending losses to reflect the benefit & cost levels expected during the period the rates will be in effect

→ There isn't a specific order in which these adjustments need to be made, but the order should still be considered so that the proper adjustments are made. For instance, if the long term expectation for extraordinary losses has already been trended to the period the rates will be in effect, this expectation should not be added to historical losses until these losses have also been trended to the same period.

→ So, even though we will start by covering adjustments to the loss data for extraordinary events or anomalies, keep in mind that this step will not necessarily be completed first before other loss adjustments are made. Later sections will address the three types of adjustments listed above, along w/ similar adjustments that should be made to the premium data.

→ Shock Losses

→ One type of extraordinary event that can be seen in loss data is **shock losses**, which are individual losses that occur infrequently & that are excessively large.

→ Some common examples of shock losses that may occur include:

→ For homeowners insurance, a total loss on a house w/ an extremely high value

→ For auto insurance, a large liability claim that involves multiple claimants

→ For worker's compensation, a young worker that experiences a total permanent disability

→ All of these are considered shock losses bc they are unlikely to occur, & they result in losses that are much higher than normal.

→ The effects of shock losses in the ratemaking process may not be as noticeable for large companies, but it can lead to instability in ratemaking for companies w/ smaller portfolios. If loss data is not adjusted for shock losses, this may cause future losses to be overestimated after a year w/ more shock losses than normal, leading to an increase in indicated rates. Conversely, if the historical losses being analyzed include fewer than normal or no shock losses, then future losses will be underestimated if shock losses aren't taken into account, leading to a decrease in indicated rates.

→ Example →

> An insured incurs an average annual loss of 2,000. Additionally, there is a 5% probability that the insured will experience a shock loss of 10,000 in any given year. Assume insurance rates are calculated as the arithmetic average of the losses from the last two years.
>
> Calculate the insured's rate, given that they experienced losses of 2,000 in each of the last two years and that a loss of 10,000 occurred in:
>
> 1. Neither of the last two years.
> 2. One of the last two years.
> 3. Both of the last two years.

→ Case 1: neither of the last two years

$$\Rightarrow \text{rate} = \frac{2000 + 2000}{2} = 2000$$

→ Case 2: One of the last two years

$$\Rightarrow \text{rate} = \frac{2000 + (2000 + 10000)}{2} = 7,000$$

→ Case 3: Both of the last two years

$$\Rightarrow \text{rate} = \frac{(2000 + 10000) + (2000 + 10000)}{2} = 12,000$$

→ Observations & Implications

→ If we base the rate on actual expected loss, assuming shock losses occur w/ a 5% probability each year, the expected annual loss would be calculated as follows:

$$2000 + 0.05(10,000) = 2,500$$

Therefore, the "ideal" rate for the insured, representing both typical & shock losses, would be $2500

→ This example demonstrates that:

→ **underestimation of losses** → If no shock losses occur, the insured pays less than the expected rate, leading to potential premium inadequacy

→ **overestimation of losses** → When one or more shock losses occur, the insured pays a significantly higher rate, potentially discouraging them from renewing their policy.

→ To stabilize the impact of shock losses, actuaries might consider using adjustment techniques ensuring premiums remain fair & sufficient w/o being overly volatile.

→ Adjusting for shock losses

→ When estimating future losses for ratemaking, it is common to make an adjustment for shock losses. The first step is to remove or minimize the impact of shock losses. Possible ways to accomplish this include:

→ Excluding shock losses entirely

→ Capping all losses based on the minimum amount of insurance offered, typically referred to as the **basic limit**, or the limit associated w/ the base rate.

→ Capping losses at a different large loss threshold

→ If shock losses are removed entirely, the remaining losses are referred to as **non-shock losses**.

→ If shock losses are capped at a threshold, then only the portion of losses above that threshold, referred to as **excess losses**, will be removed. The remaining losses are known as **non-excess losses**.

→ The second step when adjusting for shock losses is to modify the remaining losses to include a provision for either expected shock losses or expected excess losses. This provision is typically determined using a loss distribution when compared to projecting non-shock or non-excess losses) to get a more stable estimate. We will discuss how to determine this provision later in this subsection.

→ Before that though, it's necessary to first determine the threshold at which a loss is considered a shock loss). During this step, an actuary should attempt to balance two conflicting goals. The threshold chosen should:

1) Include as many losses as possible, &
2) minimize volatility in the ratemaking analysis

There are several considerations to make when choosing a threshold.

→ Using basic limit as threshold

→ While using the basic limit as a threshold may be appropriate for some cases, it won't necessarily be the point at which losses are considered extraordinary. For instance, the basic limit for auto liability is typically the amount of insurance that is required by law. However, many insureds select limits that are higher than the basic limit, which means there would likely be a significant # of losses above the basic limit. So, make sure to consider this when deciding if the basic limit should be the threshold for shock losses.

→ Another consideration for capping all losses at the basic limit is that the rate level resulting would then give the rate level needed assuming that all insureds have the basic limit. In that case, the premium should also be adjusted to the premium for the basic limit. Then, the effect of losses other than the basic limit would be considered in classification ratemaking analysis.

→ Determining a different large loss threshold

→ If losses aren't capped at the basic limit, a different large loss threshold will need to be selected. One possible method is to study the loss distribution & select a threshold at a specific percentile. For instance, one choice may be the 99th percentile, so that only 1% of claims would be considered shock losses.

→ Besides using a fixed loss amount for the threshold, it may also make sense to set a threshold that is a percentage of the amount of insurance. That's b/c the amount of insurance for some insurance products can vary significantly based on the items being insured.

→ Example →

You are given the following information about four annual insurance policies:

Policy	Effective Date	Limit	Premium
A	Jan. 1, 2022	500	400
B	Apr. 1, 2022	1,000	520
C	Jun. 1, 2022	500	400
D	Nov. 1, 2022	750	470

Policy	Accident Date	Reported Losses
A	Aug. 11, 2022	500
B	Nov. 27, 2022	650
C	Feb. 6, 2023	200
D	Dec. 18, 2022	150

- Assume that all policies have the same characteristics, other than having different limits.
- No rate changes occurred during 2022.
- The basic limit is 500.

→ Calculate the LR at basic limits for AY 2022.

→ $LR = \frac{\text{AY 2022 Losses}}{\text{AY 2022 EP}}$

→ Since the LR should be at basic limits, we'll need to adjust both the losses & premium to be at the basic limit

→ The loss on Policy B is the only one that is above the basic limit of 500, so that loss will be capped at 500. (Also ignore policy C since AY 2021). So, the AY 2022 losses at basic limits are

→ Policy A: 500
→ " B: 500
→ " D: 150

$\Sigma = 1,150$

→ We also need to find the premium using the rate for the basic limit of 500. From the table, notice that the policies w/ a basic limit of 500 have a premium of 400. That means we'll use the premium of 400 for each of the 4 policies. (b/c assuming basic limits)

→ Then, calculate the EP for each policy at the premium of 400 times the # of months of coverage provided in 2022, divided by 12 since the values are annual.

→ Policy A basic EP: $400\left(\frac{12}{12}\right) = 400$
→ " B " " = $400\left(\frac{6}{12}\right) = 200$
→ " C " " = $400\left(\frac{9}{12}\right) = 333.33$
→ " D " " = $400\left(\frac{3}{12}\right) = 66.67$

$\Sigma = 1000$

$\Rightarrow$ LR at basic limits for AY 2022 is: $\frac{1150}{1000} = 115\%$

→ Determining Shock Loss Provision

→ Once a threshold is set for excluding or capping shock losses, a provision for shock losses can be calculated using the following steps:

1) Separate all losses into **excess losses** & **non-excess losses**
2) Sum the excess losses
3) Sum the non-excess losses
4) Calculate the ratio of excess losses to non-excess losses
5) Calculate the **excess loss loading factor** as 1 plus the ratio found above.

Then this factor is multiplied to the historical non-excess losses to account for the long term average expected shock loss.

→ One thing to consider when calculating the provision for shock losses is how many years of data should be analyzed. While the provision should be the expected large loss amount based on a longer term, there is no set length of time that it should be based on. The # of years included can vary by line of business (LOB) & by insurer. For instance, a small umbrella insurer may need to use 20 years of loss data to determine a good loss estimate for expected shock losses, while a medium-sized homeowners insurer may only need 10 years of data. The important thing is to include enough data to get a stable & reasonable estimate of the expected large losses, w/o including too many years of data since older data becomes less relevant over time.

→ NOTE: The method covered above isn't the only way to address shock losses. Another possible approach for determining the expected shock or excess loss is to fit statistical distributions to the data & simulate claim experience, although we won't cover this approach in any more detail here.

→ As mentioned at the beginning of this subsection, adjusting losses also includes other steps besides considering extraordinary events, such as trending. Typically, losses should be trended before excess losses are calculated, as losses in higher layers of insurance generally have greater inflationary pressure compared to losses in lower layers, so there could be bias if losses aren't trended first. An alternative method is to index the excess loss threshold to reflect the trend.

→ Examples →

You are given the following reported loss information for an insurer, where shock losses are defined as any losses of at least 100,000:

Accident Year	Reported Losses	Number of Shock Losses	Ground-Up Shock Losses
2011	8,322,145	2	465,100
2012	8,719,308	3	511,315
2013	8,110,420	0	0
2014	9,028,671	3	671,490
2015	8,654,238	1	183,218
2016	9,028,750	1	236,519
2017	9,390,416	5	724,396
2018	8,221,117	0	0
2019	8,316,280	1	176,411
2020	8,891,643	4	518,706
Total	86,682,988	20	3,487,155

Using all years of data, calculate

1. the ratio of excess losses to non-excess losses.
2. total losses for accident years 2018-2020, where actual excess losses are replaced using the long-term excess loss loading factor.

→ 1) Non excess losses (for the shock losses)

total shock losses $\times$ threshold

$\left(\sum_{i=\text{year}}^{\text{year}} n_i\right) \times (100{,}000) = 2{,}000{,}000$

Excess losses

$\sum_{i=\text{year}}^{\text{year}} (Y_i - 100{,}000\, n_i) = 1{,}487{,}155$

↳ $= 3{,}487{,}155 - 2{,}000{,}000$

total non excess losses

(given)

Total reported loss − excess loss

$= 86{,}682{,}988 - 1{,}487{,}155 = 85{,}195{,}833$

$\Rightarrow$ ratio = $\frac{\text{excess}}{\text{non-excess}} = \frac{1{,}487{,}155}{85{,}195{,}833} = 0.017456$

→ 2) Total losses

$\sum_{i=2018}^{2020} Y_i = 23{,}439{,}040$

Excess losses

$\sum_{i=2018}^{2020} (Y_i - 100{,}000\, n_i) = 193{,}117$

total non excess losses

Total reported losses − Excess losses =

$25{,}439{,}040 - 193{,}117 = 25{,}245{,}923$

ratio

$1 + 0.017456 = 1.01\,7456 \Rightarrow$

Adjust non excess losses

$25{,}245{,}923\,(1.017456) = 25{,}674{,}349$

→ You are given the following reported loss information for an insurer:

Claim #	X_i Reported Losses	L_i Amount of Insurance on Policy
1	35,000	90,000
2	84,500	85,000
3	54,000	60,000
4	10,000	110,000
5	50,000	50,000
6	70,000	75,000

1. Calculate the excess loss loading factor using a cap of 80,000 and all provided data.
2. Calculate the excess loss loading factor using a cap of 90% of the amount of insurance and all provided data.
3. Briefly explain when it makes sense to cap losses at a percentage of the amount of insurance, rather than at a fixed loss amount.

→ 1) Non-excess losses

$\sum_{i=1}^{6} \left[\mathbb{I}(X_i < 80{,}000)\, X_i + \mathbb{I}(X_i \geq 80{,}000)\, 80{,}000\right] = 294{,}000$

↳ claim #

Excess losses

$\sum_{i=1}^{6} \mathbb{I}(X_i \geq 80{,}000)(X_i - 80{,}000) = 4{,}500$

$\Rightarrow$ ratio = $\frac{\text{excess}}{\text{non-excess}} = \frac{4{,}500}{294{,}000} = 0.01505$

$\Rightarrow$ factor = $1 + \text{ratio} = 1.01505$

→ 2) Non excess losses

$\sum_{i=1}^{6} \left[\mathbb{I}(X_i < 0.9L_i)\, X_i + \mathbb{I}(X_i \geq 0.9L_i)\, 0.9L_i\right]$

$= 35000 + 76500 + 54000 + 10000 + 45000 + 63000$

$= 283{,}500$

Excess losses

$\sum_{i=1}^{6} \mathbb{I}(X_i < 0.9L_i)(Y_i - 0.9L_i)$

$= 0 + 8000 + 0 + 0 + 5000 + 2500$

$= 15{,}500$

$\Rightarrow$ ratio = $\frac{\text{excess}}{\text{non-excess}} = \frac{15{,}500}{283{,}500} = 0.054674$

factor = $1 + \text{ratio} = 1.054674$

→ 3) If many more losses to cap losses at a % of amount of insurance when the amount of insurance can vary significantly based on the items being insured. using a fixed loss amount may exclude some losses that would be considered excessively large for a given insured item if the amount of insurance for that item is below the fixed amount.

→ Assignment

→ 01) Company A uses the following ten years of loss data to determine a shock loss load. Any portion of a loss that exceeds a certain threshold is considered excess.

Accident Year	X_i Ground-up Reported Losses	Z_i Excess Loss
2010	$150,000	$20,000
2011	$100,000	$3,000
2012	$148,000	$8,000
2013	$250,000	$65,000
2014	$110,000	$5,000
2015	$160,000	Y
2016	$156,000	$9,000
2017	$188,000	$18,000
2018	$111,000	$0
2019	$112,000	$6,000

After loading for excess losses, the AY2019 loss is $119,250.

Determine Y, the AY2015 excess loss.

→ AY 2019 adj loss = AY 2019 non excess loss $\times$ (1 + ratio)

$119{,}250 = (113{,}000 - 6000)(1 + r)$

$\Rightarrow r = 0.1125$

ratio = $\frac{\text{Excess}}{\text{non-excess}}$

$0.1125 = \frac{\sum Z_i}{\sum (X_i - Z_i)}$

↓ $= \frac{134{,}000 + Y}{114{,}000 + (140{,}000 - Y)}$

$0.1125\,(1{,}351{,}000) - 0.1125\,Y = 134{,}000 + Y$

$1.1125 = 1.1125\,Y$

$Y = 31000$

→ 02) Company B uses the following ten years of loss data to determine a shock loss load. Shock losses are defined as any losses of at least $20,000.

Accident Year	X_i Ground-up Reported Losses	Y_i Ground-Up Shock Losses	n_i Number of Shock Losses
2010	$308,000	$54,700	2
2011	$268,500	$21,500	1
2012	$296,000	$33,000	1
2013	$535,000	$101,200	4
2014	$246,000	$28,500	1
2015	$376,500	$75,400	3
2016	$332,000	$32,800	1
2017	$277,800	$42,200	1
2018	$252,000	$0	0
2019	$294,000	$26,500	1
Total	$3,187,800	$415,800	15

Calculate

(a) The total loss for AY2019 after loading for **shock** losses.
(b) The total loss for AY2019 after loading for **excess** losses.

→ 1) ratio = $\frac{\text{shock losses}}{\text{non-shock losses}}$

$= \frac{415{,}800}{3{,}187{,}800 - 415{,}800}$

↓ $= 0.15$

Factor = $1 + 0.15$

↓ $= 1.15$

in general:

ratio = $\frac{\text{Excess losses adjusting for}}{\sum \text{non excess losses}}$

factor = $1 + \text{ratio}$

Year i adj losses = non excess losses $\times$ factor

AY 2019 adj = non-shock losses $\times$ factor

$= (294{,}000 - 26500)(1.15)$

$= 307{,}625$

→ 2) non-excess losses

$\sum_{i=2010}^{2019} 20{,}000\, n_i = 700{,}000$

Excess losses

$\sum_{i=2010}^{2019} (Y_i - 20000\, n_i) = 415{,}800 - 700{,}000$

↓ $= 115{,}800$

Total non-excess losses

→ $\sum X_i - 115{,}800 = 3{,}072{,}000$

↳ $3{,}187{,}800$

→ ratio = $\frac{\text{Excess}}{\text{non-excess}}$

$= \frac{115{,}800}{3{,}072{,}000}$

$= 0.037769$

$\Rightarrow$ factor = $1 + 0.037769$

↓ $= 1.037769$

→ AY 2019 non excess = $\sum_{i=2019} X_i - (Y_i - 20000\, n_i)$

$= 314{,}000 - (76500 - 20000\,(1))$

↓ $= 287{,}500$

$\Rightarrow$ adjusting = $287{,}500 \times$ factor ↳ $= 1.037769$

↓ $= 298232.40$