Trending Losses

30M

Since we covered methods for developing losses in Section S5.1, we will move on to loss trending.

The general idea of ratemaking is to use historical information to determine the premium rates that should be in effect at some point in the future. Historical experience provides useful insight to the ratemaking process to an extent, but there are certain adjustments that need to be made to reflect possible changes, like inflation or changes in underwriting procedures, throughout the years.

Stated in different terms, we want to use historical information from the ***experience period*** (also known as the **historical period**), adjust it to reflect the changes mentioned above, and then use the adjusted data to calculate the premium rates that will be in effect during the ***expected effective period*** (also known as the **forecast period**) .

When we make these adjustments due to the time lags between the experience period and the calculation date and between the calculation date and the forecast period, we are trending the data.

Coach's Remarks

There is a well-known misconception called the ***overlap fallacy*** which states that developing and trending losses will double-count the effect of inflation and other possible changes.

This is not true because the development factors are used to bring immature losses to their expected ultimate values, while the trending factors are used to adjust the ultimate values from the experience period to the expected effective period.

In short, development and trending are two independent steps, both of which are important in ratemaking.

There are two components to loss trending: the trend period and the trend factor.

Trend Period

The ***trend period*** is the period of time from the average loss occurrence date of the experience period to the average loss occurrence date of the expected effective period.

To calculate the trend period, we first need to determine the experience period and the expected effective period. Then, for each period, the average loss occurrence date is simply the **midpoint** of the period.

Experience Period

The ***experience period*** is the period in which losses from historical claims could occur. We can use one of two types of data for the experience period: accident year data or policy year data.

Accident year data contain loss data for all losses occurring in a specific one-year period. Since all losses occur within this period, the average loss occurrence date is the midpoint of the **one-year** period.

- As an example, for AY2015, the experience period ranges from January 1, 2015 to December 31, 2015. The midpoint is July 1, 2015.

Policy year data contain loss data for all losses associated with policies written in a specific one-year period. Under policy year aggregation, we need to account for when the last policy written in the policy year will expire. Therefore, the experience period varies depending on the policy term.

For policy year data, the experience period has a length of $1 + k$ years, where k is the policy term. Consider the following two examples.

- **Annual Policies and PY2015 Loss Data**
  All losses for policies written in 2015 are included in PY2015. An annual policy written on December 31, 2015 would not expire until December 31, 2016. This means that for PY2015, losses could occur from January 1, 2015

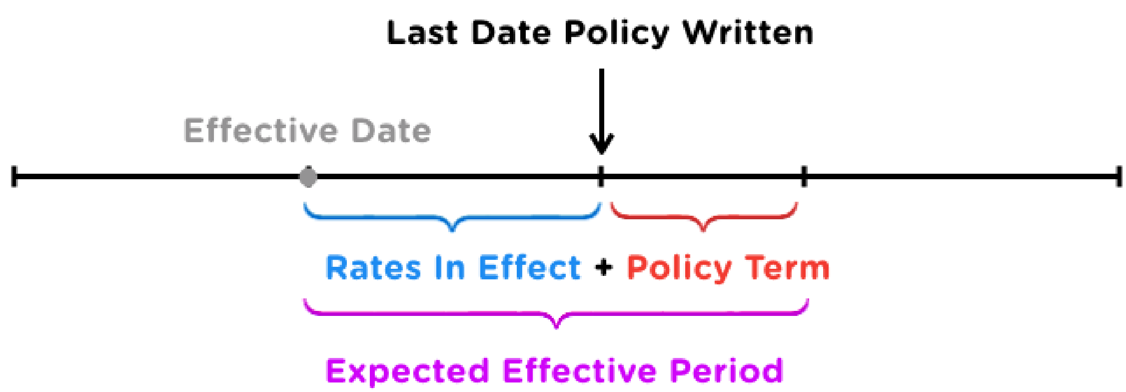
to December 31, 2016, which is a **two-year** period. The midpoint is January 1, 2016.

- **6-Month Policies and PY2015 Loss Data**
  All losses for policies written in 2015 are included in PY2015. A 6-month policy written on December 31, 2015 would not expire until June 30, 2016. This means that for PY2015, losses could occur from January 1, 2015 to June 30, 2016, which is an **18-month** period. The midpoint is October 1, 2015.

Expected Effective Period

The ***expected effective period***, also known as the ***forecast period***, is the period in which losses can occur for policies written using the new rates.

The expected effective period begins on the effective date of the new rates. Then, the length of the expected effective period is determined as the sum of two quantities: the policy term and the length of time for which the new rates are in effect.



This is because policies will be sold at the new rate for as long as the rates are in effect and because the last policy sold will be in effect for the length of the policy term. So, losses can occur at any point within this period.

- If the rates are calculated for annual policies and are effective for one year, then the expected effective period is a **two-year** time period starting from the effective date. For example, if the effective date is October 1, 2018, then the forecast period will range from October 1, 2018 to September 30, 2020, with a midpoint of October 1, 2019.

- If the rates are calculated for annual policies and are effective for six months, then the expected effective period is an **18-month** time period starting from the effective date. For example, if the effective date is October 1, 2018, then the forecast period will range from October 1, 2018 to March 31, 2020, with a midpoint of July 1, 2019.

Coach's Remarks

By default, policies are assumed to be written/issued uniformly throughout the year. However, if we instead assume policies are only written on the effective date, then all policies will expire at the same time. In this case, the expected effective period will only be as long as the policy term.

As mentioned above, the trend period is the length of time between the two average loss occurrence dates. For the following two examples, assume new rates are effective for one year and are calculated for annual policies.

- Suppose we are using AY2015 data for the experience period and October 1, 2018 as the effective date.
  - **Experience period**: January 1, 2015 to December 31, 2015
  - **Expected effective period**: October 1, 2018 to September 30, 2020
  - **Trend period**: July 1, 2015 to October 1, 2019, or 4 years and 3 months (4.25 years)
- Suppose we are using PY2015 data for the experience period and October 1, 2018 as the effective date.
  - **Experience period**: January 1, 2015 to December 31, 2016
  - **Expected effective period**: October 1, 2018 to September 30, 2020
  - **Trend period**: January 1, 2016 to October 1, 2019, or 3 years and 9 months (3.75 years)

Experience Data	Trend From Date	Trend To Date	Trend Period
AY2015	7/1/15	10/1/19	4.25 years
PY2015	1/1/16	10/1/19	3.75 years

Trend Factor

A ***trend factor*** is a factor used to adjust losses from the experience period to a cost level applicable to the expected effective period. There are many things that drive loss trends, such as monetary inflation, increasing medical costs, and technological advances.

Selecting this trend factor can be one of the most important tasks in the ratemaking process, but it can be difficult to do. In addition, there are multiple methods to decide on this numerical value, including regression, so these will not be discussed in this manual. Instead, we will assume the trend will be given and will be expressed either as a continuously compounded rate or as an effective rate.

Let's consider the following example.

You are given the following information:

- The ultimate losses, in thousands, for several accident years are given below:

Accident Year	Ultimate Losses (in thousands)
2012	1,393
2013	2,413
2014	2,206
2015	2,270

- The selected trend is an annual effective rate of 5%.
- Rates are calculated for a one-year period effective March 1, 2018.
- Annual policies are assumed to be written uniformly throughout the year.

Calculate the projected ultimate losses, in thousands, for the forecast period using AY2014 loss data.

We are given a trend of 5%. This translates to an annual trend factor of 1.05. Using AY2014 loss data, the projected ultimate losses for the forecast period is:

$$\hat{L}^{\text{ult.}} = 2{,}206(1.05)^t$$

Note that t is the trend period, i.e. the period of time from the midpoint of the historical period to the midpoint of the forecast period.

- The midpoint of AY2014 is July 1, 2014.
- Since the effective date is March 1, 2018 and new rates last for a year, the midpoint of the forecast period is March 1, 2019.
- Then, there are 4 years and 8 months from July 1, 2014 to March 1, 2019, so:

$$\begin{aligned} t &= 4 + \frac{8}{12} \\ &= 4.6667 \end{aligned}$$

Therefore, the projected ultimate losses, in thousands, is:

$$\begin{aligned} \hat{L}^{\text{ult.}} &= 2{,}206(1.05)^{4.6667} \\ &= \mathbf{2{,}770} \end{aligned}$$

Coach's Remarks

On the exam, the trend might be given in a more creative way. Using the motivating example above:

- If we are given the slope m of a straight line **fitted to the losses**, we perform linear extrapolation to get the trended losses, i.e.

$$\hat{L}^{\text{ult.}} = 2{,}206 + mt$$

- If we are given the slope m of a straight line **fitted to the natural log of the losses**, then

$$\ln \hat{L}^{\text{ult.}} = \ln 2{,}206 + mt$$

Hence, the trended losses is

$$\begin{aligned}\hat{L}^{\text{ult.}} &= e^{\ln 2{,}206 + mt} \\ &= e^{\ln 2{,}206} \cdot e^{mt} \\ &= 2{,}206 \cdot e^{mt}\end{aligned}$$

Typically, actuaries use loss data from multiple years to predict losses for the forecast period. To do so, they assign weights to each year and then calculate the weighted average of the trended ultimate losses. Alternatively, some actuaries may project losses directly using only regression. As there are many ways to trend losses, it is the responsibility of the pricing actuary to justify the methodology chosen.

Coach's Remarks

Besides trending losses, we can also trend pure premium (loss per unit exposure). The result should be identical as long as the number of exposures is consistent.

Note that pure premium is not the same as premium.

Example S5.2.3.1

Garnier Insurance has the following loss experience:

Accident Year	Estimated Ultimate Losses (in thousands)
2015	3,188

Accident Year	Estimated Ultimate Losses (in thousands)
2016	3,242
2017	3,427

Actuary Jon is asked to forecast premium rates for a one-year period effective June 1, 2018. Jon decides on a trend of 6% per year compounded continuously. He assigns weights to each accident year's loss experience.

Accident Year	Weight
2015	20%
2016	30%
2017	50%

Garnier only writes annual policies.

Calculate the projected ultimate losses in thousands for the forecast period assuming:

1. policies are written uniformly throughout the year.
2. all policies are written on June 1, 2018.

Solution to (1)

Begin with losses from AY2015. The average loss occurrence date for AY2015 is July 1, 2015. Since new policies are written uniformly, the average loss occurrence date for the forecast period is June 1, 2019. So, the trend period is 3 years and 11 months, or 3.9167 years.

With $t = 3.9167$, the trended ultimate losses for AY2015 is:

$$\begin{aligned} \hat{L}^{\text{ult.}}_{\text{AY2015}} &= 3{,}188e^{0.06(3.9167)} \\ &= 4{,}032.53 \end{aligned}$$

Calculate the trended ultimate losses for AY2016 and AY2017 using similar steps. The results are tabulated below.

Accident Year	Weight	Trend Period	Trended Ultimate Losses
2015	20%	3.9167	4,032.53
2016	30%	2.9167	3,862.02
2017	50%	1.9167	3,844.66

Finally, the projected ultimate losses for the forecast period is the weighted average of the trended ultimate losses using the assigned weights:

$$\begin{aligned}\hat{L}^{\text{ult.}} &= 0.20\,(4{,}032.53) + 0.30\,(3{,}862.02) + 0.50\,(3{,}844.66) \\ &= \mathbf{3{,}887}\end{aligned}$$

Solution to (2)

Recall that if the policies are only written on the effective date, then the forecast period has the same length as the policy term. Hence, the average loss occurrence date is the midpoint of a one-year period.

Since policies are written only on June 1, 2018, the average loss occurrence date of the forecast period is December 1, 2018, which is the midpoint of the period from June 1, 2018 to June 1, 2019. Note that the average loss occurrence dates are the same for the historical periods.

Then, the trended ultimate losses for each accident year are as follows:

Accident Year	Weight	Trend Period	Trended Ultimate Losses
2015	20%	3.4167	3,913.35
2016	30%	2.4167	3,747.88
2017	50%	1.4167	3,731.03

Finally, the projected ultimate losses for the forecast period is:

$$\begin{aligned}\hat{L}^{\text{ult.}} &= 0.20\,(3{,}913.35) + 0.30\,(3{,}747.88) + 0.50\,(3{,}731.03) \\ &= \mathbf{3{,}773}\end{aligned}$$