6.2.2 → Analyzing the development method (cont...)

→ Changes in product mix

→ Imagine you're estimating unpaid claims for an insurance company that writes several lines of business. To streamline the process, you decide to pool the data across lines instead of projecting each line separately. As long as the mix of business doesn't change much over time, this shortcut works just fine. But what happens when one product line starts to grow rapidly while another stays flat?

→ Suddenly, the underlying assumptions you've relied on – especially about how development factors should be weighted – may no longer hold. This can quietly distort your results.

→ A growing line can skew the picture

→ Let's say line A is a smaller, newer product + line B is larger + well-established. Initially, line B dominates the data, so it heavily influences any average development factors. But over time, line A grows quickly. If you're still using development factors that reflect the old ratio between the two lines, your estimates will drift off course. Here's a simple case that illustrates how things can go right — if your product mix is stable.

Claims data is given for two different product lines below.

Accident Year	Line	Claims @ 12 Months	Development Factor (12-to-Ult)	Estimated Ultimate
2020	A	$100	4.0	$400
2020	B	$1,000	2.0	$2,000

→ Now let's combine these into a single estimate.

→ First, calculate a weighted average development factor based on the 12-month claims:

$$\text{weighted avg dev factor} = \text{weight}_A \times \text{Dev Factor}_A + \text{weight}_B \times \text{Dev Factor}_B$$

$$= \frac{100}{100+1000} \times 4.0 + \frac{1000}{100+1000} \times 2.0$$

$$\approx 2.182$$

→ Apply this to the combined reported claims:

$$\text{ultimate claims} = \text{Weighted Avg Dev Factor} \times \text{Combined reported claims}$$

$$= 2.182\ (100 + 1000)$$

$$= 2400$$

→ That matches what you'd get by developing each line separately:

$$\text{ultimate claims} = \text{Dev Factor}_A \times \text{Claims}_A + \text{Dev Factor}_B \times \text{Claims}_B$$

$$= 4.0\,(100) + 2.0\,(1000)$$

$$= 2400$$

→ So, when the mix of business is stable, aggregating lines w/ a weighted average factor provides reliable estimates.

→ So far, we've seen that combining claims from multiple product lines using a weighted development factor works if the relationship between those lines stays stable over time. But what if both lines grow? And what if they grow at different speeds?

→ Let's start w/ the easy case

→ Case 1: Equal growth (steady state: no change in product mix)

→ Assume both lines A + B are expanding at the same pace — say 10% annually. In that case, even though claims volumes are increasing, the relative size of each line stays the same. This means the balance we relied on last year still holds this year.

→ Here's how the updated data for 2021 may look:

Accident Year	Line	Claims @ 12 Months	Development Factor (12-to-Ult)
2020	A	$100	4.0
2020	B	$1,000	2.0
2021	A	$110	4.0
2021	B	$1,100	2.0

→ Since both lines grow at the same rate, the product mix is unchanged. So it's perfectly reasonable to reuse the weighted average development factor we previously calculated (≈ 2.182). We can validate this by calculating the weighted average development factor based on the 12-month claims:

$$\text{Revised weighted Avg Dev Factor} = \text{Weight}_A \times \text{Dev Factor}_A + \text{Weight}_B \times \text{Dev Factor}_B$$

$$= \frac{110}{110+1100} \times 4.0 + \frac{1100}{110+1100} \times 2.0$$

$$= 2.182$$

→ As expected the weighted average development factor remains unchanged. Applying it to the total claims:

$$\text{Ultimate Claims} = \text{Revised weighted avg Dev Factor} \times \text{Combined reported claims}$$

$$= 2.182 \times (110 + 1100)$$

$$= 2640$$

→ Again, if we break it out by line + develop them separately, we get the same answer:

$$\text{ultimate claims} = \text{Dev Factor}_A \times \text{Claims}_A + \text{Dev Factor}_B \times \text{Claims}_B$$

$$= 4.0\,(110) + 2.0\,(1100)$$

$$= 2640$$

→ So far, the shortcut continues to work — b/c the underlying proportions haven't changed. Both the reported + paid claim development methods yield estimated IBNR values that match the actual IBNR. Provided that the mix of business across various categories remains stable — + no significant operational or environmental shifts occur — the development method is expected to produce a reliable estimate of unpaid claims.

→ Case 2: Uneven growth (changing product mix)

→ Now let's add a twist. Suppose line A is booming, growing at 20% per year, while line B grows more modestly at 5%. The data now looks like this:

Accident Year	Line	Claims @ 12 Months	Development Factor (12-to-Ult)
2020	A	$100	4.0
2020	B	$1,000	2.0
2021	A	$120	4.0
2021	B	$1,050	2.0

→ Since both lines grow at different rates, the product mix has changed. Consequently, it is no longer appropriate to reuse the previously calculated weighted average development factor of approximately 2.182. We can confirm this by recalculating the weighted average development factor using the new proportions:

$$\text{Revised weighted avg Dev Factor} = \text{weight}_A \times \text{Dev Factor}_A + \text{weight}_B \times \text{Dev Factor}_B$$

$$= \frac{120}{120+1050} \times 4.0 + \frac{1050}{120+1050} \times 2.0$$

$$\approx 2.205$$

→ As expected, the weighted average development factor has changed, + it is higher than 2.182. Applying it to the total claims:

$$\text{ultimate claims} = 2.205\,(120+1050) = 2580$$

→ Observe that if we instead develop each line separately + sum the results, we arrive at the same ultimate claims:

$$\text{ultimate claims} = 4.0\,(120) + 2.0\,(1050) = 2580$$

→ But what happens if we erroneously reuse the original weighted average development factor of 2.182, which was appropriate only when the product mix was stable? Here's the result:

$$\text{ultimate claims} = 2.182\,(120 + 1050) \approx 2552.727$$

→ This is lower than the correct value of 2580. This discrepancy arises b/c a larger share of the total claims now comes from line A, which has a higher development factor (4.0). As a result, the appropriate weighted average should shift closer to line A's development factor, reflecting the updated claim distribution.

→ This example highlights a critical issue: the development method is backward-looking. It assumes the future mirrors the past. So if the product mix is evolving — especially if one line is growing disproportionately – it can bake in a bias.

→ In this case, our method would likely underestimate ultimate claims. Over time, as the faster-growing line takes on more weight + we continue using outdated factors, the error compounds. What started as a small divergence could quietly snowball into a material shortfall in reserves.

→ Below is a summary of the important relationships from this section.

<table>
<tr><th rowspan="2">Description</th><th colspan="2">Impact on Development Method</th></tr>
<tr><th>Paid</th><th>Reported</th></tr>
<tr><td>Increase in exposures</td><td colspan="2">If exposures distribution is stable year over year, claims increase but development factors are unaffected. If exposures distribution change, causing the average accident date to shift, claims projection may be distorted.</td></tr>
<tr><td>Increase in claim ratios</td><td colspan="2">Claims increase, but development factors are unaffected</td></tr>
<tr><td>Speedup in claim settlement rates</td><td>Overestimates development factors and ultimate claims</td><td>No effect</td></tr>
<tr><td>Increase in case outstanding adequacy</td><td>No effect</td><td>Overestimates development factors and ultimate claims</td></tr>
<tr><td>Change in product mix</td><td colspan="2">Development factors change to reflect the new mix</td></tr>
</table>

→ For a slowdown/decrease in any of these factors, the change would have the opposite effect. For example, a slowdown in the claims settlement rate would cause the paid method to underestimate development factors + ultimates but would not impact the reported method.

→ Example →

Given the following data as of 12/31/2014 for an insurer that writes auto coverage in two states:

Underwriting Year	State A Earned Premium ($000s)	State B Earned Premium ($000s)
2012	3,000	120,000
2013	8,000	118,000
2014	26,000	111,000

<table>
<tr><th rowspan="2">State</th><th colspan="4">Paid CDFs as of (months)</th></tr>
<tr><th>12</th><th>24</th><th>36</th><th>48</th></tr>
<tr><td>A</td><td>2.53</td><td>1.72</td><td>1.14</td><td>1</td></tr>
<tr><td>B</td><td>2.51</td><td>1.68</td><td>1.13</td><td>1</td></tr>
</table>

- State A policy limit is $50,000
- State B policy limit is $25,000

(a) Discuss an argument for and an argument against combining State A and State B when performing an unpaid claims analysis using the paid development method.

(b) Discuss the expected change in severity from 2012 to 2014 when combining the experience from State A and State B using the paid development method.

→ a) → Reason for combining the states

→ The paid CDFs from the two states are very similar, indicating similar development patterns. Therefore, combining the two states will likely produce a more reliable estimate for State A than analyzing it individually.

→ Reason against combining the states (any one of the following):

→ The two states are experiencing different growth rates. State A is growing rapidly, while State B appears to be slowly declining. This difference may cause the average accident dates for State A to shift forward, leading to a different claims development pattern.

→ When analyzing claims, the underlying product mix should be stable over time. Here, the two states have different policy limits, + one state is growing faster than the other. Therefore, the product mix is likely to become more unstable in the coming years.

→ b) → The combined severity would be higher in 2014 than in 2012.

→ The higher policy limit in State A suggests that its severity is likely greater than that of State B. Additionally, as State A is growing rapidly, it will account for a larger share of the total product mix in the coming years. Consequently, the combined severity is expected to increase over time.

→ Notes → Note that b/c we're using the paid development method, increasing severity is not a reason to avoid combining the data. This is b/c the development factors remain unaffected by changes in severity. However, there are other loss reserving methods, which we have not yet discussed, where changing severity could pose a problem.

→ Assignment

→ Q1) For each scenario described below, assume the paid development method is being used to estimate ultimate claims.

(a) Describe the potential impact of a slowdown in settlement rates on the estimate.

(b) Describe the effect that a decrease in case reserve adequacy can have on the estimate.

(c) Discuss the impact on the development factors if there is a decrease in both frequency and severity.

(d) Describe a scenario where changes in the product mix can distort the estimate.

→ **SOLUTION TO PART (A)**

In general, an increase or decrease in the settlement rate would impact age-to-age factors and ultimate claim estimates in the same direction as the change in settlement rate when using the paid development method. Thus, the ultimate claim would be **underestimated** in this case.

SOLUTION TO PART (B)

Since changes in case reserve adequacy have no impact on the paid loss data, the estimated ultimate claims would **not be affected**.

SOLUTION TO PART (C)

There **would not be** an impact on the development factors; however, the estimate will decrease.

SOLUTION TO PART (D)

One common scenario where this can occur is when a relatively new line is combined with an older stable line. If the newer line is growing much faster than the older line, the proportion of claims attributable to the new line would increase over year.

→ Q2)

(a) Briefly describe the reported claim development technique to determine IBNR.

(b) For each of the following situations described below, state whether the reported claim development technique would understate, overstate, or produce the correct indicated IBNR.

(i) Deteriorating loss ratio and consistent case reserves.

(ii) Consistent loss ratio and strengthened case reserves.

→ **SOLUTION TO PART (A)**

The Reported Claim Development Method for estimating IBNR uses historical patterns of claims development to project future claims. It involves:

- **Calculating Cumulative Development Factors (CDFs)**: Historical claims data are used to estimate how much more claims are likely to develop after each evaluation point for each accident year. These factors reflect how reported claims have developed over time.
- **Projecting Ultimate Claims**: The reported claims to date are multiplied by the CDFs to estimate the ultimate incurred claims for each accident year.
- **Determining IBNR**: The IBNR is calculated as the difference between the projected ultimate incurred claims and the actual reported claims to date.

SOLUTION TO PART (B)

(i) A changing loss ratio by itself does not necessarily imply that the ultimate claim amounts are shifting, assuming all other factors remain constant. As a result, the IBNR estimate would still be accurate.

(ii) The reported development method would interpret higher reported claim amounts as an increase in claim severity rather than a change in the reporting pattern. This would cause the selected development factors to partially reflect earlier periods when reserves were less adequate and claims had more potential for development. Consequently, the improvement in reserve adequacy would lead to an overestimation of ultimate claims, which would, in turn, result in an overestimation of IBNR.

→ Q3) While conducting the year-end 2007 reserving analysis, the actuary observes higher-than-expected reported and paid losses in accident year 2007.

All high-severity claims reported on or after January 1, 2007 have been handled by a newly established office that specializes in such claims. Compared to the prior office, this new office establishes higher initial case reserves and settles claims more promptly.

(a) Explain the effect that the new claims-handling procedure will have on the liability estimate produced by the unadjusted reported loss development method.

(b) Explain the effect that the new claims-handling procedure will have on the liability estimate produced by the unadjusted paid loss development method.

(c) Suppose, instead, that there had been no changes in the claims handling, but the actuary still observes higher-than-expected reported and paid losses in accident year 2007. Provide two questions that the actuary might ask the underwriting manager to help identify the source of the change in the loss data.

→

1. Generally, a change in reserve adequacy will affect the selected ultimate factor and the ultimate claim estimates in the same direction as the change in reserve adequacy when using the reported development method. Therefore, the ultimate losses for accident year 2007 will be overstated.

2. Typically, a change in the settlement rate will impact the age-to-age factors and the ultimate claim estimates in the same direction as the change in the settlement rate when using the paid development method. As a result, the ultimate losses for accident year 2007 will be overstated.

3.
   - Have there been any significant changes in our underwriting guidelines?
   - Have we been underwriting any large risks that are not typical for our usual book of business?
   - Have there been any changes in the mix of business written?