6.2.0 → Overview

→ Overview → In section 2.3, we discussed the development triangle.

→ In this section, we will focus on estimating ultimate claims + unpaid claims using both reported + paid claim development methods. The development technique, also referred to as the chain ladder technique, is among the most widely used methods for estimating unpaid claims

→ We conclude the section by examining the assumptions underlying the development method + evaluating how changes in an insurer's environment impact this reserving approach

6.2.1 → The development technique

→ Overview → In section 2.3, we introduced the basics of the chain ladder method, also called the development technique. Here, we will review that method, make a few additional observations, + then show how it can be used to estimate unpaid claims.

→ Here are the seven steps of the development technique:

→ 1) Compile claims data
→ 2) Calculate age-to-age factors
→ 3) Calculate averages
→ 4) Select claim development factors
→ 5) Select tail factor
→ 6) Calculate cumulative development factors
→ 7) Project ultimate claims

→ To illustrate this process, consider the scenario below.

→ Example →

Suppose we have the following incremental paid claims data for a line of business.

Accident Year	Incremental Paid Claims as of (months)						
	12	24	36	48	60	72	84
2011	590	490	380	200	70	70	30
2012	590	370	260	90	40	20	
2013	690	750	430	270	170		
2014	790	610	440	170			
2015	750	660	450				
2016	770	800					
2017	870						

Assume no further development after 84 months.

Calculate the unpaid claims estimate as of December 31, 2017 using the chain-ladder method and the arithmetic average factor model.

→ Before proceeding, it's important to understand how to read this table. Recall its three dimensions:

→ Columns
→ Rows
→ Diagonals

→ Column → Each column represents twelve development months, which indicates the age of the claim. For example, the first column ("12") records payments that were made in the calendar year in which the claims occurred. The second column ("24") records payments that were made in the next calendar year.

→ Row → Each row represents one accident year (AY). For example, row "2012" records the payments made on claims from AY 2012, i.e. claims that occurred in 2012. Note that the payments were not all made in 2012.

→ Thus, the total payment that has been made on claims from AY 2012 as of Dec 31st, CY2017 is

$590 + 370 + 260 + 90 + 40 + 20 = 1,370$

→ Diagonal → Each upward-sloping diagonal represents one calendar year (CY).

Accident Year	Incremental Paid Claims as of (months)						
	12	24	36	48	60	72	84
2011	590	490	380	200	70	70	30
2012	590	370	260	90	40	20	
2013	690	750	430	270	170		
2014	790	610	440	170			
2015	750	660	450				
2016	770	800					
2017	870						

→ Thus, the total payments made in 2013 are:

$690 + 370 + 380 = 1,440$

→ Let's now explore the development technique.

→ Step 1: Compile claims data

→ In the development technique, cumulative data is used. Since we are given incremental data, simply sum along the row to create the cumulative paid claims triangle:

Accident Year	Cumulative Paid Claims as of (months)						
	12	24	36	48	60	72	84
2011	590	1,080	1,460	1,660	1,730	1,800	1,830
2012	590	960	1,220	1,310	1,350	1,370	
2013	690	1,440	1,870	2,140	2,310		
2014	790	1,400	1,840	2,010			
2015	750	1,410	1,860				
2016	770	1,570					
2017	870						

→ Step 2: Calculate age-to-age factors

→ As we did in section 2.3, in each row, divide the subsequent claim by the previous claim. Doing so, we get the following age-to-age factors:

Accident Year	Age-to-Age Development Factors					
	12-24	24-36	36-48	48-60	60-72	72-84
2011	1.831	1.352	1.137	1.042	1.040	1.017
2012	1.627	1.271	1.074	1.031	1.015	
2013	2.087	1.299	1.144	1.079		
2014	1.772	1.314	1.092			
2015	1.880	1.319				
2016	2.039					

→ Step 3: Calculate averages of age-to-age factors

→ Previously, we provided four different ways of calculating averages. As a refresher, these are the arithmetic (or simple), medial, geometric, + volume-weighted averages:

Type of Average	Average Age-to-Age Development Factors					
	12-24	24-36	36-48	48-60	60-72	72-84
Arithmetic Average	1.873	1.311	1.112	1.051	1.028	1.017
Medial Average	1.880	1.311	1.115	1.051	1.028	1.017
Geometric Average	1.866	1.311	1.111	1.051	1.028	1.017
Volume-Weighted Average	1.880	1.312	1.114	1.055	1.028	1.017

→ Step 4: Select claim development factors

→ Next, we must select which age-to-age factors we want to use. There are some key points to keep in mind when reviewing the claim development experience:

→ Smooth progression → Ideally, there is a smooth decrease in factors across development years (i.e. as the claims approach maturity).

→ Stability → w/in each column, a low variance in development factors signifies stability

→ Credibility of experience → Volume + homogeneity determine credibility. If credibility is lacking, then as a last resort industry benchmark development factors may need to be used instead.

→ Changes in patterns → Reviewing age-to-age factors can help identify patterns that reflect internal +/or external changes

→ Applicability of the historical experience → Actuaries should use qualitative information to determine how applicable historical development will reflect future claim development

→ Shock losses / cat losses → Sometimes, we might observe a single very large claim that distorts the development factors for a given year/age.

→ In our example, the age-to-age factors are very similar, + whichever we select will not result in a significant difference

→ Notes → It's common on the exam to justify your selection of development factors.

→ For example, if development factors are increasing from AY to AY, you might select the most recent age-to-age factors instead of taking an average. Or, if a particular AY has an age-to-age factor that is much larger than the ones for other years, you could assume that the large factor is an outlier + average the age-to-age factors for the development period excluding the outlier.

→ As long as you can justify your selection, there usually isn't a "correct" choice: the goal is to demonstrate that you can think critically in a real-world situation

→ Industry remarks → When selecting LDFs in practice, the selection often depends on what the goals are. A lower factor could be selected if the goal is for pricing to become more competitive, + a higher factor could be selected if we wanted reserves to be more conservative.

→ Step 5: Select tail factor

→ In some cases, there may be development on a single claim that occurs after the last column in a development triangle. When data that is still developing is used, a tail factor can be used to develop the claim to ultimate levels. A tail factor is simply a development factor that accounts for any development after the most recent period included in the triangle.

→ Actuaries use three approaches to evaluate the tail factor:

→ Industry benchmark development factors
→ Curve fitting to extrapolate the tail factors, i.e. exponential decay
→ Utilizing reported-to-paid ratios at the latest observed paid development period

→ The third approach is specifically used for paid development where the comparable reported development is already considered to be at ultimate.

→ For our purposes, since we assume that claims are fully developed at 84 months, all tail factors are 1.00. If we were to assume that claims were still developing after 84 months instead, we would need to select a tail factor that accounts for development between 84 months + whenever claims reach ultimate levels.

→ Step 6: Calculate cumulative claim development factors (CDF)

→ Losses are multiplied by their cumulative development factors. Using the arithmetic average factors, here are the CDFs:

Paid CDF at 84 months = 1.000

— — — 72 — — — = 1.017 (1.000) = 1.017

— — — 60 — — — = 1.028 (1.017) = 1.045

o
o
o

— — — 12 — — — = 1.873 (1.600) = 2.996

→ e.g.) 72-to-ultimate

Cumulative Paid Claim Development Factors						
12	24	36	48	60	72	84
2.996	1.600	1.221	1.098	1.045	1.017	1.000

→ Step 7: Project ultimate claims

→ For each AY, multiply the most recent cumulative paid claim by its respective claim development factor

Accident Year	CDF	Ultimate Claim
2012	1.017	1,392.83
2013	1.045	2,413.41
2014	1.098	2,206.48
2015	1.221	2,270.26
2016	1.600	2,512.16
2017	2.996	2,606.85

→ Finally, w/ the ultimate claim amounts projected for each AY, we can subtract the cumulative paid claims to get the unpaid claims estimate for each AY:

Accident Year	Ultimate Claim	Cumulative Paid Claims	Unpaid Claims Estimate
2012	1,392.83	1370	22.83
2013	2,413.41	2,310	103.41
2014	2,206.48	2,010	196.48
2015	2,270.26	1,860	410.26
2016	2,512.16	1,570	942.16
2017	2,606.85	870	1,736.85

→ The total unpaid claims estimate is the sum of the last column, or 3,412.

→ Assignment

→ Q1)

Given the following information:

Valuation Date	Accident Year	Incremental Paid Loss
Dec. 31, 2018	2018	$1,200
Dec. 31, 2018	2017	600
Dec. 31, 2018	2016	150
Dec. 31, 2018	2015	75
Dec. 31, 2017	2017	2,000
Dec. 31, 2017	2016	700
Dec. 31, 2017	2015	250
Dec. 31, 2016	2016	1,800
Dec. 31, 2016	2015	600
Dec. 31, 2015	2015	1,300

Accident Year	Cumulative Paid Loss			
	12 Months	24 Months	36 Months	48 Months
2015	$1,300	$1,900	$2,150	$2,225
2016	1,800	2,500	2,650	
2017	2,000	A		
2018	1,200			

	12-24 Mos.	24-36 Mos.	36-48 Mos.	48-Ultimate
Age-to-age factors	B	1.08	1.04	1.000

(a) Using the volume-weighted average for B, calculate the values for A and B.

(b) Use the factor you solved for in part A and the development technique to estimate the unpaid claim liability for accident year 2018 as of December 31, 2018.

→

Valuation Date	Accident Year	Incremental Paid Loss	Age
12/31/18	2018	$1,200	12
12/31/18	2017	$600	24
12/31/17	2017	$2,000	12
12/31/18	2016	$150	36
12/31/17	2016	$700	24
12/31/16	2016	$1,800	12
12/31/18	2015	$75	48
12/31/17	2015	$250	36
12/31/16	2015	$600	24
12/31/15	2015	$1,300	12

Accident Year	Cumulative Paid Loss			
	12 Months	24 Months	36 Months	48 Months
2015	$1,300	$1,900	$2,150	$2,225
2016	$1,800	$2,500	$2,650	
2017	$2,000	$2,600 =SUM(D4:D5)		
2018	$1,200			

Accident Year	Age-to-age factors		
	12-24	24-36	36-48 / 48-Ult
2015	1.462	1.132	1.035 =F17/E17
2016	1.389	1.060 =E18/D18	
2017	1.300 =D19/C19		
2018			

	12-24 Mos.	24-36 Mos.	36-48 Mos.	48-Ultimate
Age-to-age factors	1.37 =SUM(D17:D19)/SUM(C17:C19)	1.08	1.04	1

	12-Ult	24-Ult	36-Ult	48-Ult
CDFs	1.54 =PRODUCT(C24:F24)	1.12 =PRODUCT(D24:F24)	1.04 =PRODUCT(E24:F24)	1

Est ultimate AY 2018 losses as of 12/31/2018 = $1,849.98 =C20*C28

Unpaid claim liability = $649.98 =K28-C20

→ Q2) Given the following claim data as of December 31, 2020:

Accident Year	Cumulative Reported Claims (000s)				
	12 Months	24 Months	36 Months	48 Months	60 Months
2016	$605	$765	$840	$875	$880
2017	$600	$775	$860	$890	
2018	$616	$785	$875		
2019	$622	$810			
2020	$628				

- No development is expected after 60 months.
- Use an all-year straight average for all factor selection.
- Accident year 2019 paid claims as of December 31, 2020 = $750,000

(a) Use the reported development technique to estimate the unpaid claims for accident year 2019.

(b) Briefly describe when a tail factor may be needed to estimate unpaid claims under the reported development technique.

(c) Briefly describe two approaches to determine a tail factor.

→

Accident Year	Cumulative Reported Claims (000s)				
	12 Months	24 Months	36 Months	48 Months	60 Months
2016	$605	$765	$840	$875	$880
2017	$600	$775	$860	$890	
2018	$616	$785	$875		
2019	$622	$810			
2020	$628				

Accident Year	Age-to-age factors				
	12-24	24-36	36-48	48-60	60-Ult
2016	1.264	1.098	1.042	1.006	
2017	1.292	1.110	1.035		
2018	1.274	1.115			
2019	1.302 =Q37/P37				

	12-24	24-36	36-48	48-60	60-Ult
Selected age	1.283 =AVERAGE(P42:P45)	1.107	1.038	1.006	1.000

	12-Ult	24-Ult	36-Ult	48-Ult	60-Ult
CDFs	1.484 =PRODUCT(P48:T48)	1.1564	1.044	1.006	1.000

AY 2019 est ult reported claims as of 12/31/2020 = $936,695 =(Q37*Q52)*1000

Accident year 2019 paid claims as of December 31, 2020 = $750,000

Unpaid claims = $186,695 =S55-S57