

## PART 3

### PREPARING THE DATA

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Part 3 describes how actuaries prepare the two primary sources of data used in actuarial work, claims and exposures. The focus of Chapter 10 is on claims and counts, and specifically on the creation of development triangles. Using detailed information from 35 claim transactions, numerous development triangles for claims and counts are constructed. In the example contained in Chapter 10, detailed transactional data are used to exemplify the aggregation of claim data by accident year and calendar year.

In Chapters 11 and 12, attention is on the exposures, both premiums and other exposures. The primary objective of Chapter 11 is to describe how exposures are earned over varying time intervals; and the objective of Chapter 12 is to identify and describe the adjustments for changes in rate level that are required for historical premiums in preparation for actuarial work.

As explained in Chapter 3, a generic naming convention is used for identifying years throughout this textbook to avoid references to any particularly timeframe. Calendar year  $i$  is identified as  $CY_i$ , accident year  $i$  as  $AY_i$ , report year  $i$  as  $RY_i$ , underwriting year  $i$  as  $UY_i$ , and fiscal year  $i$  as  $FY_i$ . For example, the sample claim transactions used in Chapter 10 are assumed to occur over a four-year calendar experience period running from January 1,  $CY_1$  through December 31,  $CY_4$ . The claim transactions are aggregated by accident year to produce development triangles consisting of the four accident years  $AY_1$  through  $AY_4$ . The same naming convention is used in Chapter 11 to describe a sample of ten policies with policy effective dates over a two-year calendar period,  $CY_1$  and  $CY_2$ .

Chapter 12 introduces Auto Insurer, a fabricated personal lines GI company writing; Auto Insurer's experience in one line of business (TPL BI) and one jurisdiction is analyzed throughout this textbook. It will be used throughout the remainder of this textbook to demonstrate the application of various methods for projecting ultimate claims and alternative methods for ratemaking. The historical experience for Auto Insurer is aggregated on a calendar year/accident year basis (i.e., exposures are aggregated on a calendar year basis, and claims are aggregated on an accident year basis). Therefore, the experience period for Auto Insurer runs from  $CY_1$  through  $CY_{12}$  for exposures and from  $AY_1$  through  $AY_{12}$  for claims.

Recall from the introductory comments to this textbook that calculations in the tables are carried to a greater number of decimals than shown, and thus values described in the text may be slightly different from expectations. This will be true of all calculations in Parts 3 through 8 and the appendices of this textbook.



# CHAPTER 10

## THE DEVELOPMENT TRIANGLE

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### Key Learning Objectives for Chapter 10

- Describe the key components of data development triangles;
- Create a data development triangle from calendar year-end reports and detailed claim transactions data;
- Calculate calendar year paid and reported claims from detailed claim transactions and accident year paid and reported claim development triangles.

### Important Terminology Introduced in Chapter 10

- Development triangle
- Experience period
- Maturity age
- Incremental values
- Cumulative values
- Calendar year paid
- Calendar year reported

## 10.0 INTRODUCTION

The **development triangle** is one of the GI actuary's most important tools for analyzing the historical relationships in the data for the purposes of projecting similar relationships into the future. Development triangles are fundamental to some of the most frequently used methodologies for projecting ultimate claims and counts. Actuaries also rely on development triangles for investigative analyses to determine the effect of organizational and environmental changes on historical claims.

Development triangles are created from successive valuations of aggregated claim experience for specific intervals of time. Actuaries use development triangles for numerous types of data and with various intervals for the **experience period** and the **maturity age**.

## 10.1 KEY COMPONENTS OF THE DEVELOPMENT TRIANGLE

Key components of the development triangle include:

- Experience period;
- Maturity age; and
- Data.

These three components are presented in Figure 10.1.

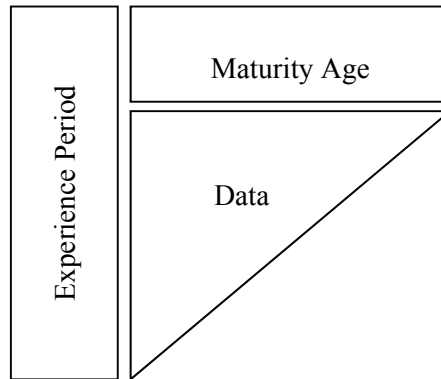


Figure 10.1 Key Components of the Development Triangle

The experience period, which is represented by the rows in the triangle, can be a year, a quarter, or even a month. The most frequently used time intervals for the experience period are accident year and underwriting year.<sup>66</sup> For claims-made GI products, the experience period is based on report years; and for self-insurers, the experience period is often based on fiscal years.

The data in each row of the experience period represents a fixed group of claims. For example, in an accident year claim development triangle, the row associated with AY1 represents all claims with accident dates in AY1; in an underwriting year claim development triangle, the row associated with UY7 represents all claims arising from policies underwritten in UY7. The rows can also represent time intervals other than years. For example, some large insurers analyze data by accident-quarter or accident half-year periods; for these insurers, the experience period would include accident quarters or half-year intervals.

The maturity age refers to the time interval from the beginning of the experience period to the valuation date of the claims. Development triangles can be compiled based on annual, semi-annual, quarterly, or monthly valuations of claims. Triangles based on annual valuations of claims are the most common for actuarial analyses and for financial reporting disclosures in accordance with current IFRS. The data in each column represents a specific maturity age. Thus, in an accident year claim development triangle, the column associated with a maturity age of 12 months represents the claim experience for each accident year valued at the end of the first year; and the column associated with a maturity age of 60 months represents the claim experience for each accident year valued at the end of five years. For example, referring to the maturity age of accident year data using calendar years, GI actuaries would say that claims from AY1 shown in the “12 months” column of the triangle are valued at the end of CY1 and claims from AY1 shown in the “60 months” column of the triangle are valued at the end of CY5.

<sup>66</sup> Underwriting year is frequently used by actuaries for aggregating data from reinsurers.

Virtually any type of data can be displayed in a development triangle, including:

- Reported, paid, and case estimates of indemnity, ALAE, or claims (i.e., indemnity and ALAE combined);
- Reported, closed, and open counts;
- Recoveries, including reinsurance and S&S;
- Average values;
- Ratios (such as the ratio of ALAE to indemnity or the ratio of closed counts to reported counts); and
- Premiums.

The data in development triangles may include **incremental** or **cumulative values**. Cumulative values represent an accumulation of amounts or counts since the beginning of the experience period. Incremental values correspond to the amounts or counts that have emerged for the experience period from one maturity age to the next. For case outstanding and open counts, the values in development triangles represent values at specific points in time in contrast to incremental or cumulative values. Detailed examples of development triangles are described later in this chapter.

## 10.2 CREATING A DEVELOPMENT TRIANGLE FROM CALENDAR YEAR-END REPORTS

The following example demonstrates how to create a development triangle of accident year reported claims from four successive calendar year-end reports. Assume that claim summaries are available at each calendar year-end December 31,  $CY_i$  through December 31,  $CY_{i+3}$  with details of reported claims shown separately for accident years  $AY_i$  through  $AY_{i+3}$ ; each accident year runs from January 1 to December 31. The reported claim data (represented by the notation  $A$ ) can be summarized as shown in Table 10.1.

TABLE 10.1

Summary of Reported Claims by Accident Year at Calendar Year-end				
Accident Year	Reported Claims at Calendar Year-end			
	Dec 31, $CY_i$	Dec 31, $CY_{i+1}$	Dec 31, $CY_{i+2}$	Dec 31, $CY_{i+3}$
$AY_i$	$A_{i,i}$	$A_{i,i+1}$	$A_{i,i+2}$	$A_{i,i+3}$
$AY_{i+1}$		$A_{i+1,i+1}$	$A_{i+1,i+2}$	$A_{i+1,i+3}$
$AY_{i+2}$			$A_{i+2,i+2}$	$A_{i+2,i+3}$
$AY_{i+3}$				$A_{i+3,i+3}$

To create the reported claim development triangle, the columns change from calendar year-end dates to maturity ages. Typically, the maturity age is counted from the start of the accident year.<sup>67</sup> Thus, the development triangle becomes the version in Table 10.2.

<sup>67</sup> Some actuaries use a different protocol for labeling maturity ages. Instead of counting from the beginning of the experience period, some actuaries count from the average accident date. As an example, assume that data are available for  $AY_1$  (January 1,  $AY_1$  to December 31,  $AY_1$ ) at a first valuation date of December 31,  $CY_1$ . (In this example,  $AY_1$  is equivalent to  $CY_1$ .) Most actuaries would label this data as having a maturity age of 12 months.

TABLE 10.2

Reported Claim Development Triangle				
Accident Year	Reported Claims at Maturity Age (in Months)			
	12	24	36	48
$AY_i$	$A_{i,i}$	$A_{i,i+1}$	$A_{i,i+2}$	$A_{i,i+3}$
$AY_{i+1}$	$A_{i+1,i+1}$	$A_{i+1,i+2}$	$A_{i+1,i+3}$	
$AY_{i+2}$	$A_{i+2,i+2}$	$A_{i+2,i+3}$		
$AY_{i+3}$	$A_{i+3,i+3}$			

Each diagonal in the claim development triangle consists of the claims from successive calendar year-end reports beginning in the top left corner of the triangle. For example, the reported claims for  $AY_i$  at a maturity of 12 months (or 12-month maturity) are from the claim report at December 31,  $CY_i$ . The reported claims for  $AY_i$  at 24-month maturity are from the claim report at December 31,  $CY_{i+1}$  as are the reported claims for  $AY_{i+1}$  at 12-month maturity. In creating the development triangle in Table 10.2 from the summary presented in Table 10.1, actuaries are essentially shifting the data to the left as they replace a report date (i.e., December 31,  $CY_i$  through December 31,  $CY_{i+3}$ ) with a maturity age (12 months through 48 months).

### 10.3 CREATING A DEVELOPMENT TRIANGLE FROM DETAILED CLAIM TRANSACTION DATA

This section explains the process that would be used by GI actuaries to create development triangles based on a sample of 35 transactions occurring over a four-year calendar period for 18 individual claims. These claim transactions, which were selected to offer examples of many different types of claim activities that can occur with GI products, will be used to create development triangles for:

- Reported claims;
- Paid claims;
- Case estimates;
- Reported counts; and
- Closed counts.

The data from these transactions will also be used to determine calendar year reported and paid values that are defined and discussed later in this chapter.

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However, some actuaries label the claims as having a maturity age of 6 months since the valuation date is six months after the average accident date for the experience period (or July 1,  $AY_1$ ). This example demonstrates the critical importance of understanding the aggregation and labeling of the data to be used in actuarial work. Without a thorough understanding of the data, there is a significant risk of potential error in the introduction of industry benchmarks or comparisons with other experience.

### 10.3.1 DETAILED CLAIMS TRANSACTIONS

Table 10.3 shows the details of the 35 claim transactions that will be used throughout this chapter. Note that while payments are shown separately for indemnity and ALAE, case estimates are not; the case estimates include provision by the claim adjusters for both indemnity and ALAE. This is a common practice with many insurers.

As described in Chapter 4 – Data, the naming convention in this textbook differentiates between *claims*, which represent an amount, and *counts* (also referred to as *claim files*). Readers should also be aware that, in this textbook, occurrence date is synonymous with accident date; these two terms are used interchangeably.

### 10.3.2 EXAMINATION OF CLAIM ACTIVITIES FOR AY1

Start by examining the claims activity for claim ID 1. For this claim file, Table 10.3 includes five transactions (transaction numbers 1, 3, 10, 15, and 28) that extend over four calendar years (CY1 through CY4). The incident that leads to a claim is first reported to the insurer on February 15, CY1, which is soon after the occurrence date of January 28, CY1. Upon first report, the claim adjuster establishes an initial case estimate of 150 for the claim file. Five months later, on July 15, CY1, there is a first payment of 100 for investigation expenses, which is a type of ALAE. At July 15, CY1, the case estimate does not change from the original 150; thus, there is no entry seen in the column labeled “Case Estimate” for this transaction. Note that this second transaction for claim ID 1 represents an increase in the total reported amount for the claim. Initially, the reported claim for claim ID 1 was 150, which is the sum of the case estimate (150) and the payment amount (0) at the date of first report, February 15, CY1. As of July 15, CY1, the cumulative reported claim amount for claim ID 1 increased to 250, which is the sum of the case estimate (still at 150) and the ALAE payment of 100.

The next activity for claim ID 1 only occurs on October 15, CY2. At this time, the case estimate is increased from 150 to 200; this is recorded as 50 in the “case estimate” column, which is added to the original entry of 150.<sup>68</sup> As there are no other activities on this claim ID in CY2, the transaction at October 15, CY2 represents an increase of 50 in the cumulative reported amount for claim ID 1 during the calendar year. Observe that paid claims do not change during CY2 for claim ID 1. During CY3, the insurer makes payments of 150 for indemnity and 100 for legal and investigation; legal and investigation expenses are both categorized as ALAE. At the time of these payments (February 6, CY3), the case estimate is revised from 200 to 75 (recorded as a decrease of 125 in the transaction summary shown in Table 10.3). These transactions represent another increase in the total reported amount, as the sum of the payments at the time (250) exceeds the reduction in the case estimate (125).

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<sup>68</sup> Insurers have different ways of recording transactions on case estimates in their claim management systems. Some insurers record the change in the case estimate while others record the revised case estimate amount directly instead of the change. This difference in recording could have a significant impact on the way actuaries work with the available data. This is another example of why it is critically important for the actuary to develop a detailed understanding of the data to be used in any actuarial work.

Table 10.3

Detailed Claim Transactions

Trans #	Transaction Date	Transaction Description	Claim ID	Occurrence Date	Case Estimate	Indemnity Payment	ALAE Payment
1	Feb 15, CY1	open new claim file	1	Jan 28, CY1	150		
2	May 3, CY1	open new claim file	2	Apr 27, CY1	100	50	
3	July 15, CY1	payment on reported claim file	1	Jan 28, CY1			100
4	Dec 22, CY1	open and close new claim file	3	Dec 21, CY1		50	
5	Jan 23, CY2	open new claim file	4	Dec 26, CY1	135		
6	Mar 18, CY2	close reported claim file	4	Dec 26, CY1	-135	135	
7	Mar 19, CY2	open new claim file	5	Feb 28, CY2	225		
8	Apr 27, CY2	payment & change in case estimate	5	Feb 28, CY2	-190	100	90
9	Aug 6, CY2	open new claim file	6	Aug 1, CY2	225		
10	Oct 15, CY2	change in case estimate	1	Jan 28, CY1	50		
11	Nov 3, CY2	open and close new claim file	7	Sept 15, CY2		50	25
12	Dec 28, CY2	open and close new claim file	8	Dec 31, CY1		115	
13	Jan 3, CY3	open new claim file	9	Feb 20, CY1	315		
14	Feb 1, CY3	open new claim file	10	Aug 1, CY1	75		
15	Feb 6, CY3	payment & change in case estimate	1	Jan 28, CY1	-125	150	100
16	Feb 25, CY3	open and close new claim file	11	Dec 31, CY2		40	
17	Feb 28, CY3	open new claim file	12	Jan 2, CY3	250		
18	Mar 2, CY3	close reported claim file	5	Feb 28, CY2	-35	35	
19	Mar 31, CY3	close reported claim file	6	Aug 1, CY2	-225	0	0
20	Jul 4, CY3	reopen closed claim file	7	Sept 15, CY2	225		
21	Aug 24, CY3	open and close new claim file	13	July 31, CY3		275	
22	Nov 23, CY3	open new claim file	14	Sept 30, CY3	25		
23	Jan 2, CY4	close reported claim file	7	Sept 15, CY2	-225	100	85
24	Jan 21, CY4	close reported claim file	10	Aug 1, CY1	-75	75	
25	Feb 25, CY4	close reported claim file	2	Apr 27, CY1	-100		200
26	Feb 28, CY4	change in case estimate	12	Jan 2, CY3	65		
27	Mar 1, CY4	open new claim file	15	Feb 4, CY3	275		
28	Mar 4, CY4	close reported claim file	1	Jan 28, CY1	-75	50	25
29	Apr 4, CY4	open new claim file	16	Feb 3, CY2	210		
30	June 5, CY4	close reported claim file	16	Feb 3, CY2	-210		210
31	June 23, CY4	payment & change in case estimate	9	Feb 20, CY1	-55	55	
32	Aug 4, CY4	open new claim file	17	June 30, CY4	100		
33	Dec 16, CY4	close reported claim file	15	Feb 4, CY3	-275	100	75
34	Dec 20, CY4	close reported claim file	14	Sept 30, CY3	-25	100	
35	Dec 22, CY4	open new claim file	18	Oct 23, CY4	250	250	



The cumulative reported value for claim ID 1 at February 6, CY3 is 425, the sum of the revised case estimate of 75 and the cumulative payments of 350. On March 4, CY4, claim ID 1 is settled with a final payment for indemnity and ALAE of 75, which is equal to the case estimate at February 6, CY3. At this time, the case estimate is reduced to 0 (recorded as a decrease of 75 in the “case estimate” column) as the claim is now closed.

Table 10.4 summarizes the progression of claim ID 1 by showing the incremental reported and paid claims<sup>69</sup> as well as case estimates at each calendar year end for this claim only.

Table 10.4  
Summary of Claim Data for Claim ID 1

Type of Claim Data	December 31,			
	CY1	CY2	CY3	CY4
Incremental Paid	100	0	250	75
Case Estimate	150	200	75	0
Incremental Reported	250	+50	+125	0

Claim IDs 2 and 3 both have significantly fewer transactions than claim ID 1. Claim ID 2 is reported on May 3, CY1, just one week after the occurrence date of April 27, CY1. An initial case estimate is established for 100 and an initial indemnity payment of 50 is made on the initial report date. This claim file settles with an expense payment of double the initial case estimate almost three years later on February 25, CY4 (claim transaction 25). It is not unusual for some longer tail liability lines of GI to take several years to gather sufficient information and determine an ultimate settlement value (for indemnity and/or ALAE). It is also not uncommon for GI claims to increase over time as more information about the incident is obtained. In contrast, claim ID 3 is opened and closed on the same date (claim transaction 4), December 22, CY1, only one day after the occurrence date, with a single indemnity payment of 50.

To complete the first row of the accident year triangle (AY1), actuaries need to review all claim transactions for claims occurring in CY1 regardless of when they are reported or paid. There are a total of seven counts with an occurrence date in AY1 (claims ID 1, 2, 3, 4, 8, 9, and 10). Claim IDs 4 and 8 are reported in CY2, and claim IDs 9 and 10 are reported in CY3. Claim ID 4 is similar to the three claim IDs reported in CY1 in that the delay between the occurrence date (December 26, CY1) and the report date (January 23, CY2) is relatively short. However, because the occurrence and report dates are in different calendar years, the reported count first appears in the development triangle in the maturity age column labeled 24 months. Claim ID 4 is an example of a claim file that is settled for the initial case estimate within a relatively short period of time. Claim ID 8 is an example of a claim file that is opened and settled on the same date; this claim file is different from other claims observed so far in that the delay between the occurrence date (December 31, CY1) and the report date (December 28, CY2) is almost one year. Claim ID 9 is reported almost two years after the occurrence date and is opened with an initial case estimate of 315. This claim file

<sup>69</sup> All tables in this chapter use the term “claims” to refer to both the indemnity and ALAE payments presented in the claim transactions detail of Table 10.3.

remains open at December 31, CY4 following an indemnity payment of 55 on June 23, CY4 (transaction 31) and an equivalent reduction in the case estimate to 260 (recorded as a reduction of 55 in the “case estimate” column of Table 10.3). The final count reported for AY1 is Claim ID 10 with an occurrence date of August 1, CY1 and an 18-month lag in reporting (report date of February 1, CY3). This claim file settles in early CY4 for 75, which is the same value as the initial case estimate.

The following tables present the case estimates, cumulative paid, and cumulative reported claims experience, respectively, for each of the seven counts occurring in AY1 based on the four calendar year-end reports. Case estimates represent a point in time value; in other words, the values in Table 10.5 represent the case estimates recorded in the system for each claim file at December 31 of each year. In contrast, cumulative paid claims and cumulative reported claims represent the sum of claim activities through December 31 of each year.

Table 10.5  
AY1 Case Estimates

Claim ID	At December 31,			
	CY1	CY2	CY3	CY4
1	150	200	75	0
2	100	100	100	0
3	0	0	0	0
4		0	0	0
8			0	0
9			315	260
10			75	0
Total	250	300	565	260

Table 10.6  
AY1 Cumulative Paid Claims

Claim ID	At December 31,			
	CY1	CY2	CY3	CY4
1	100	100	350	425
2	50	50	50	250
3	50	50	50	50
4		135	135	135
8		115	115	115
9			0	55
10			0	75
Total	200	450	700	1,105

The cumulative reported claims in Table 10.7 are the sum of the case estimates in Table 10.5 and the cumulative paid claims in Table 10.6.

Table 10.7  
AY1 Cumulative Reported Claims

Claim ID	At December 31,			
	CY1	CY2	CY3	CY4
1	250	300	425	425
2	150	150	150	250
3	50	50	50	50
4		135	135	135
8		115	115	115
9			315	315
10			75	75
Total	450	750	1,265	1,365

The rows labeled as “Total” in each of the preceding three tables become the first row in the case estimates, cumulative paid claims, and cumulative reported claims development triangles, presented in Table 10.9.

### 10.3.3 REPORTING DELAYS IN GI CLAIMS

It is not unusual for many types of GI claims to experience a delay in reporting. For some lines of GI, the lag may only be a few days, weeks or months; such a lag is typically seen in short-tail<sup>70</sup> lines including homeowners and automobile physical damage. For other lines of business, the lag may be much more significant; reporting lags of three to five years, or even longer, are not uncommon in E&O insurance, particularly medical malpractice.

In the sample set of claim transactions, most counts are reported relatively close to the occurrence date. There are some counts, however, that are reported well over a year after the occurrence date. Table 10.8 shows examples of the claim files with reporting lags affecting the development triangle (i.e., when the year of report is greater than the year of occurrence). (In Table 10.8, the report date is equal to the transaction date in which the count is first reported.)

<sup>70</sup> GI lines of business are characterized as either short-tail or long-tail, which may refer to the length of time between the date of occurrence and the reporting or the settlement of the claim.

Table 10.8  
Examples of Claim Files with  
Report Year Greater than Accident Year

Transaction Number	Claim ID	Report Date	Occurrence Date	Reporting Lag in Months
5	4	Jan 23, CY2	Dec 26, CY1	less than 1
12	8	Dec 28, CY2	Dec 31, CY1	12
13	9	Jan 3, CY3	Feb 20, CY1	23
14	10	Feb 1, CY3	Aug 1, CY1	18
16	11	Feb 25, CY3	Dec 31, CY2	2
27	15	Mar 1, CY4	Feb 4, CY3	13
29	16	Apr 4, CY4	Feb 3, CY2	26

### 10.3.4 TYPICAL GI CLAIM ACTIVITIES

The sample set of claim transactions provides other noteworthy examples of typical GI claim activities.

- Claim ID 6 is reported on August 6, CY2, within one week of the occurrence date. The adjuster sets an initial case estimate of 225 (transaction 9); the claim file is closed on March 31, CY3 with 0 payment (transaction 19). This is an example of the many claims reported to insurers that upon further investigation are found to not be covered under the insurance policy purchased by the insured.
- Claim ID 7 is first reported on November 3, CY2, less than two months after the occurrence date of September 15, CY2. The claim is settled immediately with an indemnity payment of 50 and an adjusting expense payment of 25 (transaction 11). Eight months later the claim file is reopened as more information is submitted and a case estimate of 225 is established (transaction 20). The claim file is then closed on January 2, CY4 with payments of 185 (indemnity and ALAE).

Some lines of GI are particularly susceptible to reopening, most notably workers compensation.<sup>71</sup> It is important to understand how the insurer records reopened claim files. Some insurers record reopened counts as a new claim file with a new claim ID; in this situation, the claim file would appear as a new count in the reported count development triangle. Other organizations, as illustrated in this example, retain the old claim ID and change a closed count to an open count for data recording purposes resulting in no additional counts being added to the cumulative reported count development triangle

- Counts can be closed with indemnity payment only (claim ID 4), ALAE only (claim ID 16), or both indemnity and ALAE (claim ID 15).

<sup>71</sup> Claims files for workers compensation would typically be closed when the injured employee is assumed to be fully recovered and able to return to work. In some situations, the injury may result in unanticipated consequences beyond the date at which the claim was closed. An employee may then request additional benefits for either medical expenses or lost wages associated with the original injury.

- Claim files can be closed for more than their initial case estimate (claim ID 1), less than their initial case estimate (ID 15), or the same value as their initial case estimate (ID 10).

### 10.3.5 ACCIDENT YEAR DEVELOPMENT TRIANGLES

Continuing with the analysis described for AY1, all the sample claim transactions can be aggregated to produce a variety of different development triangles. Claim development triangles are seen in Table 10.9 and count development triangles in Table 10.10.

Table 10.9  
Claim Development Triangles

Incremental Paid Claims				
Accident	At Maturity Age			
Year	12	24	36	48
AY1	200	250	250	405
AY2	265	75	395	
AY3	275	275		
AY4	250			

Case Estimates				
Accident	At Maturity Age			
Year	12	24	36	48
AY1	250	300	565	260
AY2	260	225	0	
AY3	275	315		
AY4	350			

Cumulative Paid Claims				
Accident	At Maturity Age			
Year	12	24	36	48
AY1	200	450	700	1,105
AY2	265	340	735	
AY3	275	550		
AY4	250			

Cumulative Reported Claims				
Accident	At Maturity Age			
Year	12	24	36	48
AY1	450	750	1,265	1,365
AY2	525	565	735	
AY3	550	865		
AY4	600			

Table 10.10  
Count Development Triangles

		Incremental Reported Counts			
Accident	At Maturity Age				
Year	12	24	36	48	
AY1	3	2	2	0	
AY2	3	1	1		
AY3	3	1			
AY4	2				

		Cumulative Reported Counts			
Accident	At Maturity Age				
Year	12	24	36	48	
AY1	3	5	7	7	
AY2	3	4	5		
AY3	3	4			
AY4	2				

Recall that the reopened claim file associated with claim ID 7 (transaction 20) is not recorded as a new reported count and thus does not increase the counts in the two preceding triangles of reported counts.

Incremental and cumulative closed count triangles can also be prepared based on the transactional claim data presented in Table 10.3.

#### 10.4 CALENDAR YEAR CLAIM DATA

The transaction detail can also be aggregated to produce calendar year paid and reported claim data. Calendar year paid claims are equal to the sum of payments made on claims, regardless of accident or report date, during the calendar year. Calendar year reported claims are calculated as:

$$\text{CY reported} = \text{case estimate}_{\text{end of year}} - \text{case estimate}_{\text{beginning of year}} + \text{payments in year}$$

Table 10.11 is created from the transaction detail for the purpose of aggregating the data by calendar year.

Table 10.11  
Case Estimates and Incremental Paid Claims at Calendar Year-End

Claim ID	Occ Year	CY1		CY2		CY3		CY4	
		Case Estimate	Paid	Case Estimate	Paid	Case Estimate	Paid	Case Estimate	Paid
1	CY1	150	100	200		75	250	0	75
2	CY1	100	50	100		100		0	200
3	CY1	0	50						
4	CY1			0	135				
8	CY1			0	115				
9	CY1					315		260	55
10	CY1					75		0	75
5	CY2			35	190	0	35		
6	CY2			225		0	0		
7	CY2			0	75	225		0	185
11	CY2					0	40		
16	CY2							0	210
12	CY3					250		315	
13	CY3					0	275		
14	CY3					25		0	100
15	CY3							0	175
17	CY4							100	
18	CY4							250	250
Total		250	200	560	515	1,065	600	925	1,325

Calendar year data can also be calculated directly from the development triangle. Unlike accident year data in which the claim information is aggregated based on the year of occurrence, calendar year activity contains all the transactions occurring within the 12-month calendar period regardless of the occurrence dates of claims.

Observe that transaction numbers 23 through 35, which all take place in CY4, include claim activities on four accident years, AY1 through AY4. As shown in Table 10.12, the diagonals from the preceding development triangles represent the claim activities at a calendar year-end.

Table 10.12  
Claim Data

Accident Year	At Maturity Age			
	12	24	36	48
AY1	Dec 31, CY1	Dec 31, CY2	Dec 31, CY3	Dec 31, CY4
AY2	Dec 31, CY2	Dec 31, CY3	Dec 31, CY4	
AY3	Dec 31, CY3	Dec 31, CY4		
AY4	Dec 31, CY4			

Therefore, calendar year values for paid and reported claims can be calculated from the individual claim transactions detail or directly from the development triangles.

**Calendar year paid claims** can be calculated using two approaches. First, calendar year paid claims can be developed based on an aggregation of the individual paid claims transactions during the calendar year, regardless of the accident or report date. In the second approach, the calendar year paid claims are derived based on the difference in successive diagonals of the development triangle of cumulative paid claims. In using the latter approach, it is important that the experience period contains a sufficient number of years to capture all claim payments in the calendar year.

**Calendar year reported claims** can also be calculated using two different approaches. In the first approach, claim transactions detail is used to calculate calendar year reported claims according to the following formula:

$$\text{CY reported} = \text{case estimates}_{\text{end of year}} - \text{case estimates}_{\text{beginning of year}} + \text{payments in year}$$

With the second approach, which is similar to that noted for calendar year paid claims, the calendar year reported claims are derived based on the difference in successive diagonals of the development triangle of cumulative reported claims. Again, the experience period should contain a sufficient number of years to capture all reported claims in the calendar year.

For example, for CY4, the sum of the reported claims in the last diagonal of the development triangle of cumulative reported claims is  $600 + 865 + 735 + 1,365 = 3,565$ . The sum of the second to last diagonal of this triangle is  $550 + 565 + 1,265 = 2,380$ . The difference between 3,565 and 2,380 is 1,185. Alternatively,

$$\text{CY4 reported claims} = \text{case estimate}_{\text{CY4}} - \text{case estimate}_{\text{CY3}} + \text{payments}_{\text{CY4}}, \text{ or} \\ 1,185 = 925 - 1,065 + 1,325$$

Table 10.13 summarizes the calendar year values for the claim transactions presented in Table 10.3.



Table 10.13  
Summary of Calendar Year Values

Calendar Year	Paid Claims in Year	Case Estimates End of Year	Reported Claims in Year
CY1	200	250	450
CY2	515	560	825
CY3	600	1,065	1,105
CY4	1,325	925	1,185

## 10.5 CONCLUDING REMARKS

In this chapter, sample claims transactions are used to create numerous development triangles. Development triangles are essential to many types of actuarial work, including the estimation of unpaid claims and development of prices for GI products. As will be seen in Part 4, actuaries rely on development triangles to verify the qualitative information collected to support actuarial work, to understand trends in historical claims and counts, and to project ultimate values.