Bedford Seminars

BedfordSeminars.com

Spring 2021 CAS Exam 5 Study Manual

James Bedford, FCAS, MAAA

Jim@BedfordSeminars.com

Table of Contents

Ratemaking Material

Introduction

Overview

Like many students, I found that much of the exam syllabus materials and available study guides/seminars left a lot to be desired. Explanations often lacked intuition, resulting in increased study time, memorization, and sub-par understanding. After completing my Fellowship, I decided to build the exam study material I wish I had when studying for exams.

Rather than simply regurgitating the "what" or "how" of the material, I teach the student "why". As a current practitioner I have a deep understanding of the material and extensive experience explaining complex topics in an easy to understand and intuitive way. To successfully pass exams at a comfortable rate in today's environment you need to fully understand the material on a deep and intuitive level.

To enhance my manual, I have taken what I have learned from reading the research about how we best learn and retain information, including optimal study techniques for maximum understanding and retention, along with my own experiences, and incorporated it into the design of the study manual, practice problems, and review (e.g., spaced repetition, retrieval practice, interleaving, among others, as well as study habits to avoid). In addition to the design and order, the study manual includes tips for effective studying and exam taking—along with many multi-stage diagrams that visually show how concepts tie together, assisting in the understanding of the bigger picture.

Original Practice Problems

The original practice problems are designed to maximize understanding and learning, they are not necessarily the same length, difficult, or format of actual exam questions. They are meant to be done closed book as they are designed to practice your knowledge retrieval, which will increase your retention of the knowledge. Look to the CAS exam questions to gauge your expectations for exam questions.

Excel Exhibits

I have provided working Excel exhibits containing all end of chapter exhibits and appendices from the text. These can be reviewed after reading the text or manual. Having working formulas in Excel makes following the exhibits much easier than reading exhibits in the text. Please note that there are often small differences between these exhibits and the values in the textbook due to rounding.

Condensed/Summary Notes

These notes contain chapter overviews summarized down to one page or less. They are good for intermediate review of the main topics and concepts of each chapter.

Advanced Problem Set

The advanced problem sets are often more involved than you would expect to see the actual exam. These problems have been designed to maximize understanding and learning, and are mean to be completed after working through the entire manual and original practice problems. Also, my answers to these questions are often more in depth than I would recommend for an answer on the actual exam.

Flashcards

Flashcards are provided and I highly recommend you use them in your review. Optimal use of flashcards is covered in the study tips section.

Past CAS Exam Problems

CAS questions from the current exam format (2011-present) have been included at the end of each chapter, with the exception of the past three exam sittings. These problems have been excluded from the end of chapter problems so you can take them as practice exams toward the end of studying.

Exam problems very often cover several chapters at the same time— in these situations I have assigned the problem to the last chapter covered in the problem so you have all of the information you need to solve it. In addition, this helps with spaced repetition (covered in study tips). I erred on the side of including too many problems in Chapter 15 of the reserving material as a catch all for compare and contrast type problems— do not let this cause you to underestimate the importance of the earlier chapters since they are critical to answer these questions.

Practice Exams

I have created one original practice exam. You should take this, along with the four most recent exams that I held out of the end of chapter problems, under exam conditions closer to the exam date once you have finished your second pass through the material (approximately a month out from the exam date). My original practice exam is on the long side so don't get too discouraged if you struggle with time on it.

Printing

I have inserted blank pages throughout the manual to ensure the first page of each section prints on the front of a page when printed double sided. As such, I suggest you print double sided (if you chose to print), as it will make the physical manual more manageable, and avoid printing blank pages. In addition, many of my examples and exhibits include color coding, so I very highly recommend you print in color. The practice problem sets are extremely extensive and I do not recommend printing them. I have included bookmarks within the PDFs to make electronic navigation easier.

About the Author

I am a practicing Actuary with a leading global consulting firm. Through my experience in consulting, and working for primary insurers before that, I have gained extensive knowledge in ratemaking and reserving. I am a Fellow of the Casualty Actuarial Society, and Member of the American Academy of Actuaries.

Errata

Please send errata to Jim@BedfordSeminars.com. Known errata can be found at bedfordseminars.com/errata

Studying Tips:

Research on learning shows three of the most effective methods for learning and retaining information are spaced repetition, retrieval practice, and interleaving. If you are able to incorporate these concepts into your studying, you will undoubtedly make enormous gains in efficiency and retention of the material.

1) Spaced repetition:

How many times have you studied something, only to move on to later material, then have a hard time remembering the initial topic once you have returned several weeks or months later? This is a common problem when learning something new and is an especially large problem for CAS exams where the amount of material you need to know is enormous.

Spaced repetition is the concept of increasing the intervals of time between review of material to take advantage of the spacing effect (learning is greater when spread out over time, as opposed to spending the same amount of time in condensed sessions). Doing some problems on a topic initially, then returning to do some more, say a week later, followed by a month later will drastically increase your learning and retention at the end as compared to doing all of the problems on the topic in bulk shortly after learning the material and not returning to the topic for a long period.

Flashcards are also very helpful in this regard. I personally preferred physical flashcards, but there are many websites and apps, such as Anki, that are built on the concept of spaced repetition. I would start using flashcards early, and add in flashcards for additional chapters as I progressed. I would keep the flashcards in groups, for example splitting the ratemaking and reserving material each into thirds; as time passed I would increase the time between reviewing the earlier cards as I focused more on the recent cards. This had the effect of cycling through the material while incorporating spaced repetition into the review (i.e., the lag between learning and initial review was short, but became longer for subsequent reviews). This allowed me to keep everything fresh in my mind as I learned more material.

As I was studying this I would make sure to always cycle back to do problems/flashcards on prior material while learning and progressing through the new material. It was like cycling through spaced repetition on a topic while adding more material as the need for repetition on the old material declined. I have tried to incorporate this concept into the layout of my manual and practice problems, but it is something you should keep in mind as you decide on how to layout your studying and flashcard review.

2) Retrieval Practice:

How often have you been stuck on a practice problem and glanced at the answer and thought you yourself "oh yeah, I knew that" and moved on? If you're anything like me (at least early in my exam journey) you know that process all too well—unfortunately it is terrible for learning and retention. You learn much better when you wrestle with a new problem before being shown the solution. Looking at the answer too soon only fuels the illusion of knowing – it is easy to feel as though you really understand something after you have just read it. Being able to retrieve the information unassisted is the true test of knowledge and reinforces your understanding.

You obviously aren't going to be able to glance at the answer on the real exam, so you are only cheating yourself by doing so too early while practicing. Obviously, you won't know all the answers while studying, and learning how to solve those you don't know is valuable, the point is to make sure you put forth your best effort before looking at the answer. When using flashcards don't cheat yourself by looking at the back too soon.

Struggling to retrieve information helps in learning, so it is very important to work as hard as you can to solve a problem on your own before looking at the answer—by giving up too early you are only fooling yourself, and it will mask the areas where you lack complete understanding. Difficulties in learning and retrieval only make learning stronger—when learning is easy, it is often superficial and soon forgotten.

3) Interleaving:

Interleaving is the practice of reviewing/practicing related skills in parallel, rather than separately in bulk. Interleaving your review and practice greatly helps expand both your knowledge of a given topic, and how they are related to each other. This is particularly important for this exam as so much of the material is so closely related to other topics, even between the ratemaking and reserving sections. Interleaving will also help you with knowledge retrieval come exam day. Studies have shown students who interleave their review and practice problems achieve significantly greater results than those students who review and practice the material in separate blocks.

Interleaving and spaced repetition work well together—you can cycle through initial material in longer intervals, at the same time you are incorporating new material. I strongly suggest you do some of the practice problems for a given chapter initially, then return to do more after doing the same for the next chapter, then return later to finish them. Spacing them out (in increasing intervals) and interleaving them with new topics will greatly increase your retention of the material.

It is also important for you to interleave topics in your flashcard review as well, as opposed to reviewing cards in bulk by chapter.

Below are some additional tips for studying from the literature on the topic (many are new, some are ancillary to the primary three):

1) Break up your study sessions: it is better to study in shorter sessions than longer (assuming you study the same amount in total). For example, if you want to study four hours on a Saturday your time will be much better spent studying in four one hour blocks than a single four hour block (the exception being practice exams as you want to take those under exam conditions).

2) Vary your study environment: your mind can associate information with the environment you study it, and you won't be taking the exam in the same place you are studying, so it is best to vary your studying environment from time to time.

3) Get enough sleep: getting enough sleep is critical to retaining new information as your mind organizes itself during sleep.

4) Incorporate elaboration: use your own words to explain concepts and make connections to prior knowledge.

5) Learning paragraphs (free recall): write what you can remember about what you just read (i.e., "brain dumps").

6) Use mnemonic devises to assist in remembering lists or arbitrary information.

7) Don't waste time "sliding words through your mind", it may feel like you are studying and will help rack up the hours, but will not prove beneficial to retaining or understanding the material.

8) Write your own questions: I found it extremely beneficial when learning new material to try to think of possible exam questions that could be asked, or what I would ask if writing questions for the exam. Along those same lines, when studying always ask yourself "why" and do your best to answer that question.

9) Be able to explain the concept to your boss or coworker: if you understand the material to a level you would be comfortable explaining it to someone else then you should be in pretty good shape for the exam.

10) Avoid massed practice: doing all of the problems on a topic in bulk shortly after learning it is not nearly as effective as spreading those problems out over time, and interleaving them with other topics. Massed practice is a very common practice among actuarial students, and it is very bad for retaining information. Doing end of chapter problems in smaller blocks, mixed with other chapters as well, will give you a large advantage in learning the material.

11) Re-reading and highlighting have minimal, if any, benefits on learning. Both lead to the illusion of knowing (illusion of fluency). Your time is much better spent self-quizzing, forcing yourself to retrieve the information from memory whenever possible.

If you would like more information I would highly recommend the following books: "Make It Stick: The Science of Successful Learning" and "How We Learn: The Surprising Truth About When, Where, and Why It Happens".

Exam Taking Tips:

1) Be aware of the time. It is easy to get lost "in the zone" and lose track of time. Time can seem to move especially quick in the exam setting. It is important to look up at the clock from time to time to ensure you are moving at an appropriate pace.

2) Squeeze out points from all problems, even if you cannot solve them. Write formulas, or write how you would solve the problem in general steps if nothing else (useful if you are running out of time). If stuck on an early piece of the problem that is used later, write that you are assuming an answer and move on using that assumption (you will only lose points for the first part of the problem).

3) Use bullets and concise answers whenever possible. You are not going to gain points for length or quality of sentences. The important point is demonstrating your understanding of the concept.

4) Don't contradict yourself— meaning don't hedge your bets if you are not sure of an answer (can be a common problem in written answers you are not completely sure of your answer).

5) Do your best to stay calm—doing many practice exams under exam conditions, and in various environments, will help with this.

6) Don't waste time if you get stuck. Time is your most valuable asset during the exam, so don't waste too much of it trying to pick up a point or two on a difficult problem when you could instead use that time to pick up the easier points elsewhere. Don't be afraid to move on and come back later if you are stuck.

7) Know where the bathroom is. I would almost always take one bathroom break during the exam, but I would also use that time to clear my mind, or think through a question I was struggling with. Taking a short break can be beneficial.

8) Do your best to focus on the question at hand and not worry about the one you skipped or struggled with—the answer is more likely to pop into your mind when thinking about something else or have stopped thinking about it and returned.

Estimating Unpaid Claims Using Basic Techniques

Chapter 17 – Estimating Unpaid Unallocated Claim Adjustment Expenses

Introduction

This chapter discusses several methods for estimating unpaid unallocated claim adjustment expenses (ULAE). Estimating unpaid ULAE presents a challenge because we have less information about the claims that are incurring these expenses since these expenses cannot be assigned to individual claims (i.e., since these expenses cannot be associated with an individual claim we do not know the AY and therefore don't know the maturity either). Since ULAE cannot be allocated to individual claims, we cannot group ULAE by accident year—we can only observe calendar year payments of ULAE. ULAE includes expenses such as general overhead, handling, administrative, and salary expenses of the claims department.

To predict the future ULAE expenses needed to cover current unpaid claims we can use dollar based or count based estimates. These methods use either claim dollars or claim counts to estimate ULAE. Ideally data would be available to allow us to perform both dollar and count based estimates.

ULAE also have a market value—the fees a TPA would charge to take over the claims management of the current book of business. Self-insurers often set their unpaid ULAE estimate equal to this value.

In general, these methods will vary in how we measure and select the ULAE ratio, and how the ratio is applied to estimate unpaid ULAE.

Dollar Based Techniques

Dollar based techniques assume ULAE tracks with claims dollars, both in timing and amount. Timing because they assume ULAE occurs when claims are reported or paid, and amount because they assume a $10,000 claim will incur 10x as much ULAE as a $1,000 claim. Next, we will cover several dollar based techniques.

Classical (Traditional) Technique

The classical technique uses the ratio of paid ULAE to paid claims to estimate future ULAE. The method selects the ULAE ratio by reviewing the historic ratios of calendar year paid ULAE to calendar year paid claims. In the example below we select a ULAE ratio of 5.3% based on the ratio of CY ULAE to CY paid claims in prior years, shown in Col (4). The classical method applies the ULAE ratio by assuming one half of ULAE is incurred when opening a claim, and the other half when closing a claim, so we apply 50% of the selected ULAE ratio to case reserves (since they are already open) and the full ratio to IBNR (since these claims will both open and close in the future). This results in an unpaid ULAE estimate of $21,060 in our example below.

Table 1

Calendar Year	Paid ULAE	Paid Claims	Ratio of Paid ULAE to Paid Claims
(1)	(2)	(3)	(4)
2012	12,115	214,286	0.057
2013	12,218	230,373	0.053
2014	12,242	214,929	0.057
2015	12,418	223,295	0.056
2016	12,577	251,609	0.050
Total	61,570	1,134,492	0.054
(5) Selected ULAE Ratio			0.053
(6) Case Outstanding at 12/31/16			388,031
(7) Total IBNR at 12/31/16			203,346
(8) Estimated Unpaid ULAE at 12/31/16			21,060

Notes:
(4) = (2) / (3)
(5) Selected based on ULAE ratios in (4)
(6) Given; all lines combined
(7) Estimated separately; all lines combined
(8) = (5) x [50% x (6) + (7)]

The key assumptions of the classical technique are:

1) The ratio of paid ULAE to paid claims has reached the steady state (i.e., it won't change in the future).
2) One half of ULAE is incurred when opening a claim, and the other half when closing a claim.
3) ULAE on unreported claims is proportional to IBNR and ULAE on open claims is proportional to case reserves.

The assumption that 50% of ULAE is incurred when opening and the other 50% when closing the claim is likely not a good assumption—actuaries can somewhat adjust for this by altering the ratios (e.g., 75% to case and the full amount to IBNR for long tailed lines that require substantial claims handling through the life of the claim (i.e., opening the claim may only incur 25% of the costs)).

A further enhancement we can make to this method is to estimate pure IBNR, and only apply the full ULAE ratio to this amount since the remaining amounts of IBNR are claims that have already been opened, so it would be better to apply 50% of the selected ratio to these amounts since they have already been opened, rather than the full amount. If in our example we assumed pure IBNR makes up two thirds of the total IBNR, our new unpaid ULAE estimate would be lower, as shown below.

Table 1a

(5) Selected ULAE Ratio	0.053	Notes:
(6) Case Outstanding at 12/31/16	388,031	(5) Same as in Table 1
(7) Total IBNR at 12/31/16	203,346	(6) Given; all lines combined
(7a) Pure IBNR	135,564	(7) & (7a) Estimated separately; all lines combined
(8) Estimated Unpaid ULAE at 12/31/16	19,264	(8) = (5) x {50% x [(6) + (7) - (7a)] + (7a)}

The text mentions a common approximation of pure IBNR is to assume it equals 5% of the most recent AYs ultimate claims (I fail to comprehend how this is a reasonable estimate, but I wanted to mention it for completeness). The text also states we should test any assumptions we make when estimating pure IBNR. One test would be to estimate pure IBNR as (Ult. Counts – Reported Counts) x Ultimate Severity.

In short, this method does a poor job of estimating unpaid ULAE in most situations—it assumes expenses are only incurred when opening and closing claims, is inaccurate if volume is growing or declining, if there is inflation, or if evaluating a long-tailed line of business. It will only give good results for very short tailed and stable lines of business.

Kittel Refinement (to the Classical Technique)

The Kittel refinement adjusts how we estimate the ULAE ratio (but not how we apply it). Kittel observes ULAE is also incurred when claims are reported, not just when claims are paid (as included in the denominator when measuring the ULAE ratio in the classical technique). The classical technique recognizes this in the application of the ratio, but not in measuring the ratio itself (it instead assumes a steady state where paid claims are approximately equal to reported).

Instead of using calendar year paid claims in the denominator of the ratio, the Kittel refinement uses the average of CY paid claims and CY reported claims (using the definition where CY reported = CY paid + Δ case + Δ IBNR = CY paid + Δ unpaid). In measuring the ULAE ratio, this refined method assumes half of ULAE is proportional to paid claims and half is proportional to reported claims.

The mechanics of the Kittel refinement are illustrated in the following example:

Calendar Year	Paid ULAE	Paid Claims	Reported Claims	Average of Paid and Inc. Claims	Paid ULAE to Avg Paid and Inc. Claims
(1)	(2)	(3)	(4)	(5)	(6)
2012	12,115	214,286	412,337	313,312	0.039
2013	12,218	230,373	379,249	304,811	0.040
2014	12,242	214,929	335,890	275,410	0.044
2015	12,418	223,295	333,564	278,430	0.045
2016	12,577	251,609	366,179	308,894	0.041
Total	61,570	1,134,492	1,827,219	1,480,856	0.042

(7) Selected ULAE Ratio	0.040
(8) Case Outstanding at 12/31/16	388,031
(9) Total IBNR at 12/31/16	203,346
(10) Estimated Unpaid ULAE at 12/31/16	15,894

Notes:
(5) = Average of (3) and (4).
(6) = (2) / (5)
(7) Selected based on ULAE ratios in (6)
(8) Given; all lines combined
(9) Estimated separately; all lines combined
(10) = (7) x [50% x (8) + (9)]

If CY reported claims are larger than CY paid claims the Kittel estimate will be smaller than that of the classical technique (and vice-versa, since they are both in the denominator). Like with the classical technique, we can improve our estimate by splitting out pure IBNR and applying 50% of the ratio to everything except the truly unreported piece (pure IBNR), and 100% only to the pure IBNR.

The key assumptions of the Kittel refinement are:

1) ULAE is incurred as claims are reported, even if no payments are made.
2) Calendar year ULAE payments are related to both the reporting and payment of claims.
3) ULAE on unreported claims is proportional to IBNR and ULAE on open claims is proportional to case reserves.

While the Kittel technique addresses the distortion in the classical technique when the insurer is growing (or shrinking), it still measures and selects the ULAE ratio assuming 50% of ULAE is incurred when opening and 50% while closing a claim (we can select a different allocation when applying the ratio as discussed in the classical discussion).

Conger and Nolibos—Generalized Kittel

The generalized Kittel allows judgment in setting the weights used to calculate the ULAE ratio. The Kittel refinement selects the ULAE ratio assuming 50% of ULAE is incurred when opening a claim and 50% when closing a claim and accomplishes this by using a simple average of CY paid claims and CY reported claims in the denominator of the ratio.

The generalized Kittel adds a third component to measure the costs associated with maintaining the claims that remain open. This maintenance cost can be a large portion of the total expense in long tailed lines such as workers' compensation. Conger and Nolibos believe handling larger claims requires more resources, so they use dollars rather than counts (like the previous methods).

The key assumptions of the generalized Kittel approach include:

1) ULAE costs are related to claims dollars (same for all dollar based methods, but not explicitly listed for the prior two in the text).
2) ULAE costs for opening claims are proportional to the ultimate estimate of claims reported in the period (RY ultimate).
3) ULAE costs for maintaining claims are proportional to payments made (CY paid claims).
4) ULAE costs for closing claims are proportional to ultimate costs on claims closed in the year.

The "claims basis" (denominator of the ULAE ratio) is then equal to:

$$U_1 * RY\ ultimate\ claims + U_2 * CY\ paid\ claims + U_3 * ultimate\ cost\ of\ claims\ closed\ in\ CY$$

where:

U_1 is the assumed percentage of ultimate ULAE spent opening claims;
U_2 is the assumes percentage of ultimate ULAE spent maintaining claims;
U_3 is the assumed percentage of ultimate ULAE spent closing claims (since the generalized method allocates costs to maintaining claims, it is standard to assign no additional costs to closing claims).

The example below assumed 60% of ULAE is spent opening claims, while 40% is spent maintaining claims (and there is no additional cost to close a claim).

Table 3-- Conger Nolibos 60/40

Calendar Year	Paid ULAE	Report Year Ult. Claims	Paid Claims	Claims Basis	ULAE Ratio	
(1)	(2)	(3)	(4)	(5)	(6)	
2012	12,115	258,741	214,286	240,959	0.050	
2013	12,218	268,102	230,373	253,010	0.048	
2014	12,242	275,070	214,929	251,014	0.049	
2015	12,418	281,072	223,295	257,961	0.048	
2016	12,577	285,170	251,609	271,746	0.046	Notes:
Total	61,570	1,368,155	1,134,492	1,274,690	0.048	(3) Estimated separately; all lines combined
						(5) = .60*(3) + .40*(4)
(7) Selected ULAE Ratio					0.048	(6) = (2) / (5)
(8) Ultimate Claims					2,051,885	(7) Selected based on ULAE ratios in (6)
(9) Indicated Unpaid ULAE Using:						(8) Estimated separately; all lines combined
(a) Expected Claim Method					36,920	(9a) = [(7) x (8)] - (2) Total
(b) Bornhuetter-Ferguson Method					37,305	(9b) = (7) x [(8) - (5) Total]
(c) Development Method					37,540	(9c) = {[(8) / (5) Total] - 1.00} x (2) Total

As you can see in Row (9) above, there are 3 ways to estimate unpaid ULAE when using the generalized technique:

1) The first (9a) is analogous to the expected claims method as it estimates expected ultimate ULAE [(7) x (8)] and subtracts paid ULAE to date [(2) Total]. The authors do not like this option since it can be difficult to quantify CY paid ULAE corresponding to only the AYs contained in (8), and it can also result in unrealistic estimates if claims do not approach the expected ultimate claims in (8).
2) The second (9b) is analogous to the BF method and is the preferred method of the authors (and is most similar to classical and Kittel methods). It multiplies the selected ULAE ratio by expected remaining claims (estimated ultimate claims minus the claims basis).
3) The third (9c) is analogous to the development method, using ultimate claims/claims basis as the CDF. Like the first way, this relies on being able to quantify CY paid ULAE corresponding to the AYs contained in (8) and can be overly responsive to random fluctuations in paid ULAE (just like the development method applied to claims is).

Simplification of the Generalized Kittel

Conger and Nolibos note that estimating the RY ultimates and the ultimate cost of claims closed in each year may not be a trivial exercise, so they present a simplification to the generalized technique where these estimates are not needed (we didn't need the estimate of ultimate claim costs closed in each year in our previous example since we made the common assumption that U_3 equals 0).

The first simplification is using estimated ultimate claims by AY as a proxy for the ultimate cost of claims reported in the calendar year. The second simplification is assuming that since we have allocated costs for maintaining claims, there are no additional costs to actually close the claim (thus U_3 is 0, meaning we don't need an estimate of ultimate cost of claims closed in each year since it is multiplied by 0, as in our prior example). This results in the claims basis being equal to $U_1 * AY\ ultimate\ claims + U_2 * CY\ paid\ claims$. From there we find the ULAE ratio like normal—the CY paid ULAE divided by the claims basis.

Unfortunately, the simplification does not extend to the application of the ratio—only to the estimation of the ratio. The math and notation is confusing in the paper (they use the same notation to mean different things in the text), so I would just recommend memorizing the resulting formula for our estimated unpaid ULAE when using the simplification:

$$Unpaid\ ULAE = ULAE\ Ratio\ x\ [U_1\ x\ pure\ IBNR + U_2\ x\ (Ult.Est. - \sum CY\ Paid)]$$

The following example shows the simplification to the generalized Kittel using U_1 = 60% and U_2 = 40%.

Table 4

Year	Cal Year Paid ULAE	Acc Year Ultimate Claims	Cal Year Paid Claims	Claims Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)
2012	12,115	318,905	214,286	277,057	0.044
2013	12,218	320,581	230,373	284,498	0.043
2014	12,242	312,728	214,929	273,608	0.045
2015	12,418	304,484	223,295	272,008	0.046
2016	12,577	295,187	251,609	277,756	0.045
Total	61,570	1,551,885	1,134,492	1,384,928	0.044
(7) Selected ULAE Ratio					0.044
(8) Ultimate Claims					1,551,885
(9) Estimated Pure IBNR					135,564
(10) Indicated Unpaid ULAE					10,925

Notes:
(3) Estimated separately; all lines combined
(5) = .60*(3) + .40*(4)
(6) = (2) / (5)
(7) Selected based on ULAE ratios in (6)
(8) = Col (3) Total
(9) Estimated separately; all lines combined
(10) = (7) x [60% x (9) + 40% x {(8) - (4) Total}]

Mango-Allen Refinement to the Classical Technique

Mango-Allen present a method we can use if the actual historical CY claims are volatile. The method is simply the classical technique, but uses expected CY paid claims in place of actual CY paid claims.

If actual CY claim payments are volatile, actual AY claim payments will also be volatile, so the authors suggest multiplying an expected claims ratio by earned premium to find AY expected claims (like the expected claims method does), then using industry payment patterns to spread the AY claims out over future CYs, like in the following table.

Table 5

Accident Year	Direct Earned Premium	ECR	Expected Claims	Expected Payment % in CY 2013	2014	2015	2016	Expected Claims Paid in CY 2013	2014	2015	2016
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2013	699,800	60%	419,880	12%	15%	15%	15%	50,386	62,982	62,982	62,982
2014	668,880	60%	401,328		12%	15%	15%		48,159	60,199	60,199
2015	655,520	60%	393,312			12%	15%			47,197	58,997
2016	627,120	60%	376,272				12%				45,153
Total	2,651,320		1,590,792					50,386	111,141	170,379	227,331

Notes:
(3) Estimated in separate analysis
(4) = (2) x (3)
(5)-(8) Based on industry data
(9) to (12) = (4) x [(5) to(8)]

Once we have expected CY payments (total row of Col (9)-(12)) the method is identical to the classical technique (shown with and without the adjustment for pure IBNR).

Table 6

Calendar Year	Paid ULAE	Expected Paid Claims	Paid ULAE to Expected Paid Claims
(1)	(2)	(3)	(4)
2013	12,218	50,386	0.242
2014	12,242	111,141	0.110
2015	12,418	170,379	0.073
2016	12,577	227,331	0.055
Total	49,455	559,236	0.088

(5) Selected ULAE Ratio	0.070
(6) Case Outstanding at 12/31/16	388,031
(7) Total IBNR at 12/31/16	203,346
(8) Pure IBNR at 12/31/16	135,564
(9) Estimated Unpaid ULAE at 12/31/16 w/o pure IBNR adjustment	27,815
(10) Estimated Unpaid ULAE at 12/31/16 w/ pure IBNR adjustment	25,443

Notes:
(3) Developed in Table 5, Cols (9) - (12) Total
(4) = (2) / (3)
(5) Selected based on ULAE ratios in (4)
(6) Given; all lines combined
(7)-(8) Estimated separately; all lines combined
(9) = (5) x [50% x (6) + (7)]
(10) = (5) x [50% x {(6) + (7) - (8)} + (8)]

The Mango-Allen refinement is useful for insurers with limited or highly volatile claims payment experience as the method will increase stability. The refinement is unlikely to be necessary, or improve the estimate, for insurers with sufficient volume.

A disadvantage of the dollar based techniques covered in this section is the assumption ULAE tracks with magnitude of claims dollars, which may not be the case in reality (e.g., the ULAE on a $1M claim may be less than the ULAE on 10 $100,000 claims). An additional disadvantage is ULAE becomes a “rider” on the estimate of unpaid claims, responding to the volatility in our estimate— we do not expect actual unpaid ULAE to respond fully to these fluctuations. We will explore count based techniques next.

Count Based Techniques

Rather than assuming ULAE is proportional to claim dollars, count based techniques assume ULAE is proportional to claim counts. We will first explore the generalized approach to claim counts. The approach is similar to the generalized Kittel, but uses counts rather than dollars. Several of the methods covered in this section are special cases of the generalized technique. One of the largest challenges of using count based techniques is obtaining accurate and consistent data.

Generalized Approach to Claim Counts

The generalized approach uses relative costs of opening (v_1), maintaining (v_2), and closing (v_3) claims. The relative weights are then applied to CY reported, CY open (end of period), and CY closed claims, respectively, to find a weighted "count basis":

$$Count\ Basis = v_1 * CY\ Rep.Counts + v_2 * Open\ Counts\ (end\ of\ CY) + v_3 * CY\ Closed\ Counts$$

In the following example, we assume opening a claim costs twice as much ULAE as maintaining a claim, and closing a claim costs ¼ the ULAE as maintaining (i.e., a weight of 2.0 to reported counts, 1.0 to open counts (at end of the year), and 0.25 to closed counts). We then find the ULAE ratio relative to this count basis.

Table 7

Calendar Year	Paid ULAE	Reported Counts (in CY)	Open Counts (at end of CY)	Closed Counts (in CY)	Count Basis	ULAE Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2012	12,115	597	451	546	1,597	7.58
2013	12,218	604	436	619	1,662	7.35
2014	12,242	615	430	621	1,669	7.33
2015	12,418	628	435	623	1,689	7.35
2016	12,577	637	440	632	1,712	7.35
Total	61,570	3,081	2,192	3,041	8,330	7.39

(8) Selected ULAE Ratio 7.39

Notes:
(6) = 2.0*(3) + 1.0*(4) + 0.25*(5)
(7) = (2) / (6)
(8) Selected based on ULAE ratios in (7)

After we have selected the ULAE ratio, we must apply it to each future CY separately. This example assumes all claims will be closed in the next 4 years, shown in Table 8. The unpaid ULAE for each future CY is the selected ULAE ratio times v_1*Reported Counts + v_2*Open Counts + v_3*Closed Counts. The total expected unpaid ULAE is the sum of unpaid ULAE by CY, or 12,929 in the example below. We must look at counts by CY separately to capture the number of open counts at the end of each year.

The text mentions we could vary our selected ULAE ratio by future period (e.g., due to inflation), in such case we would need to calculate unpaid ULAE by CY (we don't vary the ULAE ratio by year but do calculate unpaid ULAE by year in our example below). If we use a fixed ULAE ratio we can sum of the counts across CYs and apply the formula once to the total counts assuming we don't otherwise need separate estimates by CY (i.e., apply the formula to the total row alone).

Table 8

Calendar Year	Reported Counts (in CY)	Open Counts (at end of CY)	Closed Counts (in CY)	Unpaid ULAE
(1)	(2)	(3)	(4)	(5)
2017	215	305	350	6,079
2018	147	177	275	3,989
2019	82	75	184	2,106
2020	37	0	112	754
Total	481	557	921	12,929

Notes:
(2)-(4) Estimated run off of claims occuring on or before the valuation date
(5) = ULAE Ratio *(2.0*(2) + 1.0*(3) + 0.25*(4))

Note, for the future CYs we should only include counts incurred on or before the valuation date (i.e., only accidents occurring before the valuations date, regardless if reported or not). Also, claims that are open for multiple periods will be counted multiple times, which is what we want since we assume ULAE will be incurred on those claims as long as they are open.

Wendy Johnson Technique

Wendy Johnson's technique focuses on the relative ULAE costs of the reporting and maintenance of claims. She points out that we only need to measure the relative costs (for use in the claims basis) rather than actual costs. The above generalized method is a generalization of her method, where she uses relative weights of $v_1 = 2.0$, $v_2 = 1.0$, and $v_3 = 0.0$ (i.e., ULAE incurred when a claim is opened is twice as much as incurred maintaining a claim for a year, and closing the claim costs nothing additional).

Mango-Allen—Staffing Technique

Mango and Allen present a claim based ULAE model that uses open, closed, and pending (OCP) claims along with a measure of claims staff per OCP to estimate future staffing levels, to predict future ULAE. The method first predicts future OCP claims, then multiplies that by future expected staffing levels per OCP claim, giving expected staff, which is multiplied by an estimate of ULAE per staff to estimate future ULAE.

Mango and Allen say their exposure base of OCP claims is appealing because it is a reasonable proxy for future claims department activity, count based, and uses information that can by derived from a typical reserve study.

Rahardjo

In her paper, Rahardjo recommends incorporating duration into our calculation. She states "As duration increases, so does the expense of handling the claim for the remainder of the claim's life."

Spalla

Spalla recommends using modern systems to track the time spent on various activities performed by the claims department, and use that more detailed information to perform a more detailed analysis of unpaid ULAE. If doing this, it is important to retroactively test this method to ensure it gives reasonable results.

Early Count Techniques

An early proposal for a count based ULAE estimation technique, proposed by R.E. Brian, gave equal weight to opening a claim, maintaining a claim, making a single payment, closing a claim, and reopening a claim. The actuary would then use the sum of these transactions as the basis with which to measure and predict ULAE. This proposal set forth future work (covered above) that further refined the weights and transactions used to predict future ULAE.

Triangle Based Techniques

Since actual ULAE by accident year and age are unavailable (since ULAE cannot be mapped to individual claims) we do not evaluate ULAE in a triangle like we do claims, ALAE, and claim counts. The text mentions the actuary could make assumptions about ULAE payments based on claim payments, or studies of claims department time spent by AY, to create a ULAE triangle. While the text says it is theoretically possible to create and evaluate a ULAE triangle, it points out this is rarely done in practice.

Conclusion

In practice actuaries often only use a single method for estimating unpaid ULAE. The actuary should put thought into which method(s) are appropriate for their given situation. The actuary should check their estimates for reasonability by estimating the expected number of future CY payments the ULAE estimate would cover. We would expect fewer years for short tailed lines and more for longer tailed lines.