EDUCATION COMMITTEE

OF THE

SOCIETY OF ACTUARIES

GENERAL INSURANCE

RATEMAKING AND RESERVING STUDY NOTE

FUNDAMENTALS OF GENERAL INSURANCE ACTUARIAL ANALYSIS

2019 SUPPLEMENT

by

Jacqueline Friedland, FCIA, FCAS, FSA

The Education Committee provides study notes to persons preparing for the examinations of the Society of Actuaries. They are intended to acquaint candidates with some of the theoretical and practical considerations involved in the various subjects. While varying opinions are presented where appropriate, limits on the length of the material and other considerations sometimes prevent the inclusion of all possible opinions. These study notes do not, however, represent any official opinion, interpretations or endorsement of the Society of Actuaries or its Education Committee. The Society is grateful to the authors for their contributions in preparing the study notes.

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SOCIETY OF ACTUARIES

Fundamentals of General Insurance Actuarial Analysis

- 2019 SUPPLEMENT -

Jacqueline Friedland, FCIA, FCAS, FSA

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INTRODUCTION TO THE 2019 SUPPLEMENT

SUPPLEMENT MATERIAL

In preparation for a second edition of the Fundamentals of General Insurance Actuarial Analysis, this supplement is being prepared to present additional or replacement material. The material in this supplement is to be read together with the first edition of the textbook. The following references are provided to note where the supplement material connects with the textbook:

- Section 4.4.4 in this supplement is a replacement for Section 4.4.4 in the textbook.
- Section 4.9.2 in this supplement is a replacement for Section 4.9.2 in the textbook.
- Section 11.8 is a new section that should be read between Sections 11.5 and 11.6 in the textbook.
- Part 4: The text in the supplement should be included at the end of the section "Considerations for Actuaries Working with Reinsurers" in the textbook.
- Section 13.5 in this supplement is a new section that should be read between Sections 13.3 and 13.4 in the textbook.
- Section 14.1 in this supplement adds some examples to the end of section 14.1 in the textbook.
- Section 14.4.4 in the textbook remains, with some additional text included in the supplement.
- Section 14.4.5.3 in the textbook remains, with some additional text included in the supplement.
- Section 14.8 in this supplement is a replacement for Section 14.8 in the textbook.
- Section 19.6 in this supplement is a new section that follows section 19.5 in the textbook.
- Section 20.5 in this supplement is a new section that should be read between Sections 20.2 and 20.3 in the textbook.
- Appendix H on reinsurance has been updated with additional content. For this

supplement this reinsurance appendix continues to be labeled as Appendix H, but this appendix will become a chapter in the main text for the second edition. As a result, this appendix should be considered in Part 2 of the textbook and follows Chapter 9.

- A new Appendix I is included that outlines the development analysis for excess limits and layers. This new appendix should be read with Part 4 in the textbook that covers basic methods for estimating ultimate claims.

CHAPTER 4

DATA

SUPPLEMENT MATERIAL

4.4 CLAIM DATA

4.4.4 CLAIM DATA ON GROSS AND NET OF REINSURANCE BASES (REPLACE)

In accordance with international accounting standards, insurance companies report their results both gross and net of reinsurance. Data **gross of reinsurance** include assumed reinsurance and is prior to any ceded reinsurance. Data **net of reinsurance** refer to data after reflecting cessions to reinsurers; thus, premiums net of reinsurance are gross premiums reduced to exclude premiums ceded to reinsurers, and claim data net of reinsurance refer to gross claim data reduced to exclude the claims paid by reinsurers and case estimates ceded to reinsurers.

Some actuaries separately analyze the claims on direct, assumed, and ceded bases. Net claims are equal to the sum of direct and assumed claims less ceded claims. Other actuaries analyze claims on gross (direct and assumed claims combined) and net bases; ceded results are then equal to the difference between gross and net results.

In making decisions about how best to conduct actuarial work (including aggregation of the data and selection of assumptions and methodologies), the actuary must be knowledgeable about the insurer's reinsurance program including the:

- Types of reinsurance;
- Retentions and limits;
- Treatment of LAE;
- Changes in the program throughout the experience period;
- Claims-sensitive terms and conditions that increase or decrease the insurer's responsibility for claims; and
- Exclusions that affect the actuarial work.

All the above could influence the actuary's decision-making with respect to data aggregation, methodology, and assumptions. When conducting actuarial analyses of claims on a gross, net, or ceded basis, it is important for the actuary to consider the consistency of assumptions, methodologies, and findings.

There are many factors that influence the bases on which the data are analyzed including, but not limited to:

- The type of data segregation available to the actuary;
- The volume of data;

- The significance of reinsurance on the insurer's claims experience;
- Bases used for prior analyses;
- Professional judgment; and
- In some cases, Standards.

For example, the South African Standard on technical reserving states:

> Technical provisions should be valued both gross and net of reinsurance and other recoveries, and separately for each valuation unit. Amounts recoverable should be split between reinsurance and other recoveries, for example salvages. Appropriate adjustment to the allowance for the risk of non-recovery of these assets is required. (Actuarial Society of South Africa, 2013, p. 7)

4.9 INTERNAL VERSUS EXTERNAL DATA

4.9.2 CAUTION REQUIRED WHEN USING EXTERNAL DATA (REPLACE)

In using data that are not insurer-specific, actuaries should be aware of the potentially significant differences between the lines of business being analyzed and the external data. Such differences could make the external data inconsistent with the insurer's experience.

For example, many actuaries use industry benchmark development patterns for aggregated claims experience on a state or provincial level as well as on a countrywide level. In using industry data, actuaries should take great care to evaluate the applicability and reliability of the industry benchmark. Differences may arise due to:

- *Definition of counts* – Many insurers have different guidelines for defining a count. The definition of counts could vary between insurers depending on how each insurer addresses some of the following questions: When do reported incidents become counts? Are claim files with ALAE only (no indemnity) recorded as counts? Are claim files with no payment of any kind (indemnity or ALAE) and no case estimates recorded as counts? How are reopened claim files recorded?

- *Claim management* – There are different approaches to claim management. Some companies set case estimates conservatively and others aggressively. Differences in an insurer's philosophy to setting case estimates will significantly influence future development on reported claims. Furthermore, many insurers have implemented or are in the process of implementing new claims administration systems, which often result in significant changes to the recording and management of claims. These large-scale IT initiatives can greatly influence the relevance of historical industry information for actuarial analysis.

- *Lines of business* (i.e., policy coverage) – Some lines of GI business may be more similar from insurer to insurer within a country than from one country to another. This is particularly true for GL where legal precedents and rules (such as limitations of pain and suffering damages and statutes of limitations) can greatly influence the reporting pattern of claims. Terms and conditions, standard exclusions, and policy limits may

vary greatly from country to country. Thus, the experience of multiple insurers within a global group may not be applicable from country to country because of differences in the lines of business. This can also be true for a single line of business within a country, such as personal automobile insurance, where significant differences may exist from state to state or province to province. For example, in Canada, industry experience for Ontario, which is a combination TPL and no-fault jurisdiction, would not be appropriate for use in Quebec, where insurers typically provide first-party damage coverage only, or British Columbia, where insurers provide excess coverage only above the provincial insurer's mandatory policy.

- *Underwriting* – Underwriting practices vary greatly between insurers. Some insurers target better than average risks, some non-standard risks, and some affinity groups.[1] It would not be surprising if the claims arising from different target markets displayed different characteristics. Differences can be particularly pronounced as some insurers are modernizing their operations with advanced digital services as well as robotic process automation. Such differences could greatly affect the applicability of aggregated industry data to a particular insurer's experience.

- *Geographic mix* – Insurers can have very different strategies regarding geographic targets. Some insurers seek out insureds in large urban areas, and others target insureds in smaller cities and rural areas. For example, in the United States, claim experience in major cities in the states of Florida, Illinois, and New York likely differs from the remainder of each state; similarly claim experience in a state such as California may vary greatly from the claim experience in Vermont.

- *Claims coding* – Insurers use different technologies and processes to record claims, and these have the potential to affect claim reporting and payment patterns. For example, batch processing or the requirement for verification of certain inputs before processing could delay the recording of claim transactions in the actuarial claim database. Furthermore, implementation of new claims management systems can affect the applicability of historical industry experience for projecting the future as the mapping of types of loss and other key attributes of claims are often changed.

- *Policyholder deductibles and limits* – Deductibles and limits can vary greatly based on insurers' strategies and policies, particularly for commercial coverages. Some insurers specialize in insuring small businesses and mid-sized commercial risks, and others focus on large commercial accounts. The deductibles and limits offered by insurers would vary greatly between the coverages sold to a small, family-owned grocery store and those sold to a multi-national petrochemical corporation. These differences greatly influence historical claim experience.

- *Legal precedents* – Actuaries should consider the legal environment, including the presence or absence of tort reform initiatives, and how differences in the legal environment affect the applicability and reliability of external data.

[1]An affinity group is a group of persons affiliated with the same organization (such as an employer, a university, or a professional association) for which an insurer develops special products and often special pricing.

- *Reinsurance practices* – If using industry data on a net of reinsurance basis, an actuary needs to consider the extent to which a particular insurer's reinsurance program differs from the overall industry. For example, industry data may not be appropriate for a small captive insurer who has an excess of loss reinsurance program with a very low attachment point.

Given all the potential differences from one insurer to another, actuaries considering the use of industry benchmarks need to evaluate whether the experience of an affiliate insurer with a similar philosophy of underwriting and claim management could be a more appropriate benchmark. The actuary could also explore options such as reviewing different types of external data and possibly testing the sensitivity of the results. Another option may be to use industry data with a modification factor. For example, GL insurance industry development patterns from the United States (which can be found in Schedule P of U.S. insurance returns) may be modified by a Canadian insurer to shorten the tail to reflect a less litigious environment and typically shorter periods for claims development. Similarly, Ontario industry claims development data for GL insurance may be used with a modification factor to either increase or decrease the development to reflect unique characteristics of a Canadian insurer's GL portfolio. In all circumstances, the actuary should document all sources of industry data and any modifications.

CHAPTER 11

EARNING EXPOSURES

SUPPLEMENT MATERIAL

11.8 GI POLICIES WHERE EXPOSURES ARE NOT EARNED EVENLY THROUGH THE POLICY TERM

In the examples presented in Sections 11.2 through 11.4, the underlying assumption is that the exposure to loss is constant through the policy term for the annual, semi-annual, and multi-year policies. Thus, in the examples, earned premiums are determined proportionally using a monthly pro rata calculation over the policy term. (In practice, insurers would generally earn premiums using more accurate daily pro rata earnings routines that are embedded in IT systems.) There are some types of GI policies, however, where the exposure to loss is not constant through the policy term, such as:

- Policies covering seasonal risks;
- Warranty;
- Financial guarantee;
- Property catastrophe and aggregate stop-loss reinsurance;
- Retrospectively-rated policies; and
- Policies with reinstatement premiums.

11.8.1 POLICIES COVERING SEASONAL RISKS

An example of a personal lines GI policy that covers a seasonal risk is snowmobile, where the exposure to loss is concentrated in the winter months. Depending on the geographic region, motorcycle insurance may also represent a seasonal risk, with minimal exposure to loss during the winter months. From the perspective of commercial lines insurance, ocean marine insurance may also be a type of GI coverage with seasonal risk.

Ocean marine insurance is defined by IRMI as:

> Insurance covering the transportation of goods and/or merchandise by vessels crossing both foreign and domestic waters including any inland or aviation transit associated with the shipment. This type of marine insurance also encompasses coverage for damage to the vessels involved in shipments and any legal liability arising in the course of shipment.[2]

Assuming an annual ocean marine policy term and exposure to loss that is not equal throughout the year due to cessation of shipping operations for three months, then the premiums should not be earned on a pro rata basis. For example, assume the annual premium for an ocean marine

[2] https://www.irmi.com/term/insurance-definitions/ocean-marine-coverage, assessed February 10, 2019

policy with effective dates July 1, CY1 through June 30, CY2 is 9,000 and that all shipments cease from December 1, CY1 through the end of February CY2. Earned premiums by quarter using monthly pro rata earning are:

- 3,000 for the third quarter of CY1, based on 1,000 per month for July 1 through September 30, CY1;
- 2,000 for fourth quarter of CY1, based on 1,000 per month for October and November, CY1 with no premium earned in December CY1 due to the cessation of shipping;
- 1,000 for first quarter CY2, based on 1,000 for March CY2 once shipping resumes; and
- 3,000 for second quarter CY2, based on 1,000 for each month April through June CY2, given shipping for each month.

In practice, insurers typically use daily pro rata earnings; in this example, monthly pro rata is used to simplify the calculations.

11.8.2 WARRANTY

Some general insurers issue warranty coverage, such as new home warranty policies and polices for product warranties that provide protection for mechanical breakdown or manufacturer defects. The policy terms of these GI products are typically longer than one year, often three to five years (or even longer). In warranty coverage, the exposure to claims is often significantly greater in the later years of the policy term than in the early years. As a result, a pro rata earning of the premium is not appropriate given that the financial reporting objective is to earn revenue (i.e., premium) in accordance with the delivery of service (i.e., protection for the policyholder from loss). Instead, actuarial analysis of the expected emergence of claims using many of the techniques described in Part 3 of this textbook are used to calculate earned premiums.

The following example demonstrates one approach for earning premium for a three-year new home warranty policy. Assume that based on analysis of the emergence of historical claims, the premium earnings pattern is determined to be 15% in the first year, 25% in the second year, and 60% in the third year. For a written premium of 1,200 on January 1, CY1, the earned and unearned premiums are:

- Earned premium of 180 for CY1 at December 31, CY1 (15% × 1,200) with unearned premiums of 1,020 (1,200 – 180);
- Earned premium of 300 for CY 2 at December 31, CY2 (25% × 1,200) with unearned premium of 720 (1,200 – 180 earned in CY1 – 300 earned in CY2); and
- Earned premium of 720 for CY3 at December 31, CY3 (60% × 1,200) with unearned premium of 0 (1,200 – 180 earned in CY1 – 300 earned in CY2 – 720 earned in CY3).

The earned premium for this new home warranty example is significantly different from a pro rata assumption in which the earned premium would have been 400 each year with unearned premium of 800 at CY1 and 400 at CY2.

It is important that the actuary is aware of financial reporting requirements related to specific lines of business. For example, in the United States, the NAIC has a three-part test for the unearned premium in warranty insurance. In *The Unearned Premium Reserve for Warranty Insurance*, Richard L. Vaughan paraphrases the NAIC requirements as follows:

> … the UPR must be at least as great as the greatest of (1) the amount payable if all policyholders surrendered their contracts for refund on the accounting date, (2) the sum over all in-force policies of the gross premium times the expected fraction of ultimate losses not yet incurred as of the accounting date, and (3) the expected present value of future losses, from in-force policies, not yet incurred as of the accounting date. These are called Tests 1, 2, and 3. Test 1 values the surrender option, albeit very conservatively; Test 2 recognizes earnings as risk is borne and services performed; Test 3 addresses claim-paying ability. (Vaughan, 2014, p. 3)

Unlike most traditional GI types of coverage, given the long-term nature of the policy period for warranty coverages, the unearned premium reserve is often the most significant liability (vs. the claims liability) for warranty insurance.

11.8.3 FINANCIAL AND PERFORMANCE GUARANTEE

IRMI defines financial guarantee insurance as:

> Insurance that covers financial loss resulting from default or insolvency, interest rate level changes, currency exchange rate changes, restrictions imposed by foreign governments, or changes in the value of specific goods or products.[3]

Financial guarantee insurance is differentiated from performance guarantee (such as surety insurance), which provides assurance of compensation in the event of inadequate or delayed performance of a contract.

Examples of GI products that are categorized as financial or performance guarantees include mortgage insurance, residual value insurance, and oil and gas deficiency insurance. Mortgage insurance (also known as mortgage guarantee insurance) is coverage purchased by a lender or investor to provide indemnification for loss arising from a borrower's failure to meet required mortgage payments. Residual value insurance is defined by IRMI as:

> Guarantees the owner of leased personal property (e.g., autos or equipment) a particular value at a specified future date, usually the termination of the lease. Covers the difference between the actual liquidated value of property

[3] https://www.irmi.com/term/insurance-definitions/financial-guarantee-insurance, accessed February 10, 2019

> returned to the insured lessor and the expected value of the property specified in the policy.[4]

Oil and gas deficiency insurance is used to indemnify the insured if the actual output from an oil or gas field is less than the engineering projections.

Two other GI examples are fidelity and surety insurance. Fidelity insurance is also referred to as employee dishonesty coverage, which provides protection for employee theft of money, securities, or property. IRMI describes bonds as:

> A three-party contract under which the insurer agrees to pay losses caused by criminal acts (e.g., fidelity bonds) or the failure to perform a specific act (e.g., performance or surety bonds). The principal (i.e., the party paying the bond premium) is also called the obligor (i.e., the party with the obligation to perform). If there is a default, the surety (i.e., the insurer) pays the loss of the third party (the obligee). The obligor must then reimburse the surety for the amount of loss paid.[5]

Similar to the comments about warranty insurance, the actuary must be aware of any specific financial reporting requirements related to finance and performance guarantee insurance.

11.8.4 PROPERTY CATASTROPHE AND AGGREGATE STOP LOSS REINSURANCE

Property catastrophe reinsurance for hurricanes or hail coverage are examples of GI reinsurance that may not be earned evenly through the year as the exposure to claims is not spread evenly throughout the year but instead concentrated over specific months. This coverage is similar conceptually to the seasonal risks of snowmobile, motorcycle, and ocean marine, and thus earned premiums should reflect the provision of coverage.

Another coverage that is not typically earned evenly throughout the year is **aggregate stop loss coverage**. Aggregate stop loss coverage is a form of excess of loss reinsurance that provides protection to the reinsured against the amount by which its claims (net of other reinsurance recoveries) during a specified period (usually a 12-month period) exceed an agreed upon threshold. This agreed threshold may be an amount, such as 150 million, or a percentage, such as a claim ratio of 150%. Given the nature of the coverage, the exposure to claims is much greater near the end of the policy term rather than during the initial months of coverage.

An example demonstrates the differing exposure to loss by calendar quarter for an aggregate stop-loss policy. Assume that the primary insurer has expected claims of 100 million for CY1 with exposure to claims equal throughout the year; further assume that the primary insurer purchases a 150 million aggregate stop-loss reinsurance policy for CY1. Table 11.9 presents details of the expected claims and the relationship to the aggregate stop-loss limit.

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[4] https://www.irmi.com/term/insurance-definitions/residual-value-insurance, accessed February 10, 2019
[5] https://www.irmi.com/term/insurance-definitions/bond, accessed February 10, 2019

Table 11.9

Aggregate Stop-Loss Example
Review based on Initial Expectations

Period	Expected Claims	% Required to Exceed 150M Aggregate Stop-Loss
(1)	(2)	(3)
Jan 1, CY1 - Mar 31, CY1	25	600%
Jan 1, CY1 - June 30, CY1	50	300%
Jan 1, CY1 - Sept 30, CY1	75	200%
Jan 1, CY1 - Dec 31, CY1	100	150%

Column (2) shows the cumulative expected claims each quarter. At the end of the first quarter, expected claims are 25 million, and actual claims would have to be more than 600% of expected for the aggregate stop-loss to have affect. At the end of the second quarter, expected claims are 50 million (25 million for the first quarter plus 25 million for the second quarter), and actual claims would have to be more than 300% to have affect. Similarly, at the end of the third and fourth quarters, actual claims would have to be more than 200% and 150%, respectively, to have affect.

Continuing this example, assume that actual claims in the first quarter were 35 million, which is significantly more than expected. Table 11.10 presents revised calculations that show the percentage of claims required to exceed the aggregate stop-loss limit. While the adverse claims experience in the first quarter may make the possibility of utilizing the aggregate stop-loss more likely, the first quarter claims do not yet trigger the reinsurance coverage.

Table 11.10

Aggregate Stop-Loss Example
Higher than Expected Q1 Claims Experience

Period	Expected Claims	% Required to Exceed 150M Aggregate Stop-Loss
(1)	(2)	(3)
Jan 1, CY1 - Mar 31, CY1	35	429%
Jan 1, CY1 - June 30, CY1	60	250%
Jan 1, CY1 - Sept 30, CY1	85	176%
Jan 1, CY1 - Dec 31, CY1	110	136%

There are implications to both the insurer and the reinsurer in how premiums are earned for such coverage. Some, though certainly not all, insurers and reinsurers recognize the differences in the exposure to claims for these types of coverages and modify the general assumption of even earnings throughout the policy term.

11.8.5 RETROSPECTIVELY-RATED POLICIES

There are some types of GI policies for which final premiums are not determined until after the policy expiration date. These include premiums that are based on exposures that are not known at policy inception, such as payroll or revenue. Reinsurers also frequently require an adjustment to premiums based on their ceding companies' actual experience during the policy term. The insurer (or reinsurer) may require some form of audit to be completed following the policy expiration to determine the final premium. The final premium determination for retrospectively-rated policies and dividend plans, which are used in the U.S. for workers compensation, also lags, at times significantly, the policy expiration date. Premium that is determined following the expiration of the policy is accounted for as written and earned when it enters the insurer's systems.

11.8.6 REINSTATEMENTS

Reinstatement of the policy limits in the context of reinsurance contracts is described in Appendix H. Reinstatements can also be used in primary insurance policies. IRMI defines **reinstatement premium** as:

> A prorated insurance or reinsurance premium charged for the reinstatement of the amount of a primary policy or reinsurance coverage limit that has been reduced or exhausted by loss payments under such coverages.[6]

As an example, assume a primary insurer purchased 50 million limits catastrophe excess of loss property coverage above a retention of 25 million. Assume further that a severe catastrophe event (such as a wildfire or hurricane) occurred on June 5 in which total claims were 80 million and thus the excess reinsurance layer was exhausted. Given that the insurer still faces exposure to other catastrophe events during the year, the insurer will want to reinstate its excess of loss reinsurance limit. Such reinstatement may be included within the original reinsurance premium or may require additional premiums to be paid to the reinsurer.

The cost and number of reinstatements is subject to negotiation between the insured and the insurer, or the primary insurer and the reinsurer for reinsurance. The reinstatement premium may be included in the original premium or may be an additional premium required of the insured. A reinstatement may be automatic or may require action by the insured. Some contacts allow for one or two automatic reinstatements within the original premium, with additional premium required for further reinstatements.

Reinstatement premiums can have a distorting effect on earned premiums, which are a common type of data used for projecting ultimate claims and for interpreting results from year to year. When reinstatement premiums are charged on a reinsurance policy, the primary insurer will have lower than normal net earned premiums and higher than normal claims from the event exhausting the original reinsurance protection. Thus, it is important for the actuary to be aware of when such premiums are required and how they are treated in an insurer's financial data.

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[6] https://www.irmi.com/term/insurance-definitions/reinstatement-premium, January 27, 2019

PART 4

BASIC METHODS FOR ESTIMATING ULTIMATE CLAIMS

SUPPLEMENT MATERIAL

CONSIDERATIONS FOR ACTUARIES WORKING WITH REINSURERS (ADDITIONAL TEXT)

All these considerations could lead to wider ranges in the estimates of ultimate claims for reinsurers than insurers and greater uncertainty in the resulting estimates of unpaid claims. This could result in a ratio of reserves to surplus that is higher for reinsurers than for primary insurers. Finally, the unique considerations described for reinsurers could also result in higher risk adjustments for financial reporting than those observed in primary insurers.

CHAPTER 13

THE DEVELOPMENT TRIANGLE AS AN INVESTIGATIVE TOOL

SUPPLEMENT MATERIAL

13.5 DEVELOPMENT DIAGNOSTIC ANALYSES FOR REINSURERS

The actuary for a primary insurer uses diagnostic analyses of development triangles to better understand the environment. This can be more challenging for a reinsurer. Reinsurers assume risks transferred from primary insurers. Each primary insurer has its own strategies with respect to issues such as underwriting (including target markets and product design), distribution, and claims processing; and each of these has the potential to influence claims in the development triangle. Thus, each primary insurer has its own operational environment and experiences change over time in that environment. The reinsurance actuary tends to be further removed from the details of strategic activities and changes at the primary insurer. That said, such changes have the potential to greatly influence the claims that the reinsurer may ultimately have responsibility for. While often more challenging to interpret, development-based diagnostic testing can still be important for the reinsurance actuary as he or she strives to better understand the reinsurer's own environment as well as the aggregated effect of its cedents.

CHAPTER 14

THE DEVELOPMENT METHOD

SUPPLEMENT MATERIAL

14.1 KEY ASSUMPTIONS OF THE DEVELOPMENT METHOD

The end of Section 14.1 contains a list of examples of changes over time or other differences in the mix of business that could be material to development patterns. The last bullet point is replaced with the following three points:

- Claims associated with policy limits of 5 million per occurrence with an underlying 500,000 deductible are likely very different than claims associated with policy limits of 250,000 per occurrence with a 25,000 deductible. Similar comments apply for both insurance and reinsurance policies; in a reinsurance arrangement, the deductible would be referred to as the insurer's retention or the reinsurer's attachment point. Consequently, changes in the average deductibles (or retentions) and policy limits in the portfolio of insureds can lead to changes in the development patterns for both claims and counts.

- Claims associated with quota share reinsurance are very different than claims associated with excess of loss reinsurance. Similarly, claims associated with excess of loss reinsurance differ from claims arising from a reinsurance AAD. Thus, an actuary would consider the implications to historical experience of changes in the reinsurance program over time and aggregate and analyze the historical experience accordingly.

- The patterns at which attritional (also referred to as underlying) claims are reported and settled often differ from the patterns associated with large claims. Similarly, the reporting and settlement of claims associated with catastrophe events (such as ice storms, floods, and earthquakes) typically differ from the reporting and settlement of attritional and large claims. To the extent that the proportion of attritional, large, and catastrophe claims vary significantly from year to year or that the occurrence of such claims during the year varies, it may be more appropriate to conduct separate development analyses of attritional, large, and catastrophe claims.

14.4 DETAILED DESCRIPTION OF THE DEVELOPMENT METHOD – AUTO INSURER

14.4.4 STEP 4 – SELECT AGE-TO-AGE FACTORS FOR EACH MATURITY AGE INTERVAL (ADDITIONAL TEXT)

When considering the use of benchmark development patterns, from sources internal and external to the insurer, the actuary should consider the issues highlighted in Section 4.9.

14.4.5 STEP 5 – SELECT A TAIL FACTOR

14.4.5.3 Use of Benchmark Data (Additional Text)

Some organizations (such as ISO and IBC) have experience available by state or province, which can be important given the differences that can exist from region to region for the same line of business. When using industry data on a countrywide basis, the actuary should understand the potential for distortion if the insurer's distribution by region differs from the industry on an aggregated basis and make adjustments as appropriate. Such adjustments may include the selection of a higher or lower factor from that indicated by the industry benchmark. As always, the actuary should document the sources of industry data, any adjustments made to the experience, and the justification for such adjustments.

14.8 THE DEVELOPMENT METHOD AND REINSURANCE (REPLACEMENT SECTION)

14.8.1 USING THE DEVELOPMENT METHOD TO ESTIMATE CEDED REINSURANCE OF A PRIMARY INSURER

In projecting ultimate values, actuaries may determine ultimate ceded reinsurance using one of two approaches:

- Project ultimate claims gross and net of reinsurance and derive ultimate ceded reinsurance as the difference; or
- Project ultimate claims for ceded reinsurance directly.

Important considerations in determining appropriate methodology and assumptions for estimating unpaid claims include the type of reinsurance program, the credibility of the claims experience, and changes in the reinsurance program (e.g., changes in overall structure and changes in terms and conditions).

14.8.1.1 Quota Share Example for Auto Insurer

For quota share reinsurance, the ultimate ceded claims are a percentage of the gross ultimate claims. Thus, separate development analyses are not necessary as all the multiplicative relationships are the same for claims aggregated on a gross of reinsurance, ceded reinsurance, and net of reinsurance bases. To determine ultimate ceded claims, the actuary can directly apply the percentage quota share to the estimate of ultimate claims gross of reinsurance from the development method.

For example, assume that Auto Insurer maintained a quota share reinsurance program with ceded percentage of 15% for AY1 through AY6, 12.5% for AY7 through AY10, and 10% for AY11 and AY12. Using the projected ultimate claims based on total limits reported claims experience, estimates of the ultimate ceded claims are presented in Table 14.51.

Table 14.51

Auto Insurer - Third Party Liability Bodily Injury
Estimate of Ultimate Claims Ceded Reinsurance
Based on Development Method Applied to Reported Claims

Accident Year	Projected Ultimate Claims Using Rptd Dev Gross of Reins	Ceded Quota Share Percentage	Estimated Ultimate	
			Ceded to Reinsurance	Net of Reinsurance
(1)	(2)	(3)	(4)	(5)
AY1	33,265	15.0%	4,990	28,275
AY2	29,329	15.0%	4,399	24,930
AY3	26,087	15.0%	3,913	22,174
AY4	22,502	15.0%	3,375	19,127
AY5	12,977	15.0%	1,947	11,030
AY6	19,564	15.0%	2,935	16,629
AY7	17,538	12.5%	2,192	15,346
AY8	17,121	12.5%	2,140	14,981
AY9	22,639	12.5%	2,830	19,809
AY10	21,209	12.5%	2,651	18,558
AY11	23,598	10.0%	2,360	21,238
AY12	37,489	10.0%	3,749	33,740
Total	283,318		37,481	245,837

The projected ultimate claims in column (2) are from column (7) of Table 14.19. The projected ultimate claims are labelled gross of reinsurance in the preceding table and reflect claims at total limits. The quota share percentages in column (3) are provided by the reinsurance department. Column (4) is equal to column (2) multiplied by column (3). Column (5) can be calculated as column (2) minus column (4) or as column (2) multiplied by (100% minus column (3)).

14.8.1.2 Excess of Loss Example for Auto Insurer

If the reinsurance program is excess of loss, then the actuary's decision about how to aggregate the data and conduct the analysis will depend to a large extent on the volume of data and changes in the attachment point or reinsurance limit, if any, over the experience period. If the volume of ceded claims is sufficient to be credible for the purpose of selecting age-to-age and tail factors and the structure of the reinsurance program has not changed, then the actuary can conduct a similar analysis as that described in Section 14.7.2 for salvage, which is a type of recovery for the insurer.

There can be additional challenges when conducting development analyses on a ceded basis if attachment points or reinsurance limits have changed over time. Furthermore, reinsurance terms and conditions that are related to claims sharing (including treatment of ALAE) may change over time. These types of changes can complicate the review of historical claims

experience and potentially invalidate the two primary assumptions that historical experience is predictive of future experience and that activity observed to date is relevant for projecting future activity.

It is not uncommon for primary insurers to select development factors using development triangles with gross of reinsurance data and apply these factors to claims data net of reinsurance. The appropriateness of this approach depends on the attachment point and limits of reinsurance and the extent of claims experience in that layer.

Assume that Auto Insurer maintained an excess of loss insurance program with an attachment point of 1 million per claim. Per the information provided in Section 14.5 on large claims, there are three large claims, with a value of 3.5 million for AY10 and for AY12, claims of 1.5 million and 1 million. Two of these large claims exceed the excess of loss insurance program. Table 14.52 presents one approach to determine ultimate claims ceded and net of reinsurance using the projection of ultimate claims from the reported development method as the starting point.

Table 14.52

Auto Insurer - Third Party Liability Bodily Injury
Estimate of Ultimate Claims Ceded Reinsurance
Based on Development Method Applied to Reported Claims

Accident Year	Projected Ultimate Claims Using Rptd Dev Gross of Reins	Large Claims at 12/31/CY12 xs Attachment Point	Estimated Ultimate	
			Ceded to Reinsurance	Net of Reinsurance
(1)	(2)	(3)	(4)	(5)
AY1	33,265		0	33,265
AY2	29,329		0	29,329
AY3	26,087		0	26,087
AY4	22,502		0	22,502
AY5	12,977		0	12,977
AY6	19,564		0	19,564
AY7	17,538		0	17,538
AY8	17,121		0	17,121
AY9	22,639		0	22,639
AY10	18,430	2,500	2,500	15,930
AY11	23,598		0	23,598
AY12	29,491	500	500	28,991
Total	272,541	3,000	3,000	269,541

Like Table 14.51, the total limits projected ultimate claims (labelled gross of reinsurance) in column (2) are from column (7) of Table 14.19 with the exception of AY 10 and AY 12, where the ultimate claims are from line (D) of Table 14.20. Thus, the projected ultimate claims in

column (2) for AY 10 and AY 12 include an adjustment for large claims. The claims in column (3) reflect the claims value excess of the insurer's 1 million retention. The actuary typically receives this information from large claims reports provided by the claims department and reinsurance program details provided by the reinsurance department. In this example, the estimated ultimate claims ceded to reinsurance in column (4) are simply the latest estimates of the reported claims that are above Auto Insurer's retention of 1 million per claim.

Whether or not the excess claims are adjusted for further development depends on the treatment of large claims for the development of ultimate claims in column (2). In this example, given that the projected ultimate claims in column (2) do not include further development on the large claims, there is no further development included in column (3). It is important that the actuary is consistent in the assumptions for columns (2) and (3). If development factors are applied to large claims in column (2), then the actuary would need to apply development to the reported excess claims in column (3). Sources of such excess development may be based on the insurer's own experience if sufficiently credible or may be based on external benchmarks such as the RAA. Appendix I contains further examples of using the development method to project excess claims.

14.8.1.3 Relevance of Historical Data Following Change in Reinsurance Program

Changes in an insurer's reinsurance program can have a significant effect on claims experience net of reinsurance. Thus, the actuary must be knowledgeable of the reinsurance program and adjust the aggregation of data, methodologies, and assumptions as appropriate.

For example, assume a commercial property insurer had maintained a per risk excess of loss reinsurance program with a 1 million retention for ten years, with an effective date of July 1 for the reinsurance policy. Assume on July 1, CY11, this insurer changed its excess of loss reinsurance program to a 5 million retention with an AAD of 10 million.

The historical data on a net of reinsurance basis would likely not be appropriate for projecting the ultimate values for AY 11 as historical claims would be capped at 1 million. Furthermore, accident year aggregation using January 1 to December 31 may not be appropriate given the change in reinsurance program at July 1.

One approach for projecting ultimate claims net of reinsurance at December 31, AY12 includes the following steps:

- Prepare data triangles for both net and gross of reinsurance reported claims by semi-annual period over the experience period January 1, AY1 to June 30, AY11.

- Determine if there are claims in the gross of reinsurance triangle that exceed the new 5 million retention, and if so remove these claims.

- Use the data net of reinsurance to project ultimate claims for accidents occurring June 30, AY11 and prior.

- Use the data gross of reinsurance adjusted to remove claims greater than 5 million to determine development patterns to apply to reported claims data for the semi-annual periods after July 1, AY11.

- Using gross of reinsurance data with adjustments to remove claims in excess of 5 million per occurrence, combine the semi-annual projections to an annual basis and determine the likelihood of ultimate claims reaching the AAD of 10 million.

There are many other approaches that the actuary can implement. The important point is that the actuary must consider the implication of changes in reinsurance on the types of data and how such data are aggregated as well as the actuarial projection factors, including age-to-age and tail factors.

14.8.2 USING THE DEVELOPMENT METHOD TO ESTIMATE ULTIMATE VALUES FOR A REINSURER

Actuaries working with reinsurers frequently rely on the development method as one of several methods used to project ultimate values for more mature years and for short-tail lines of business. Given the lengthy lags in reporting experienced by reinsurers, the reported and paid claims may be too sparse to be relevant for use in the development method for many years in the experience period. In the reinsurance reserving chapter of *Foundations of Casualty Actuarial Science*, Patrik notes that there is an advantage and a disadvantage to using the development method for reinsurance. The advantage is that there is a strong relationship between future development and both the reporting pattern as well as the reported claims, by lag and by year. However, this strong relationship leads to a disadvantage, especially for long-tailed lines, as random deviations in reported claims will have a magnified effect because the projected ultimate values are highly dependent on reported claims. (Patrik, 2001)

The importance of the actuary using the development triangle to better understand the insurer's circumstances is discussed repeatedly in this and the previous chapter. Reinsurance actuaries are often less aware of the many operational changes that influence the claims experience of the primary insurers ceding risk. As a result, there can be greater uncertainty in assumptions for reinsurers and the resulting estimates of ultimate claims. This uncertainty is exacerbated if a reinsurer does not receive timely or complete claims data from its cedent insurers.

Changes in retentions, limits, and treatment of ALAE can affect the analysis of ultimate claims for a reinsurer just as they can for a primary insurer. Reinsurance contracts are often complex with numerous participants sharing differing layers of coverage; at times, the primary insurer will also participate in the reinsurance coverage. The layers and percentages frequently change from year to year based on the insurer's experience in the prior year as well as the overall market cycle. All of these changes can influence the data and the applicability of historical experience for projecting future experience. Thus, reinsurers will generally rely to a greater extent on methods that incorporate expected values. These methods are addressed in subsequent chapters of this textbook.

CHAPTER 19

BERQUIST-SHERMAN ADJUSTMENTS

SUPPLEMENT MATERIAL

19.6 BERQUIST-SHERMAN ADJUSTMENTS AND ACTUARIES WORKING WITH REINSURANCE

It is far more challenging for actuaries working for reinsurers to use the Berquist-Sherman adjustments to modify claims development triangles for assumed claims. The data for reinsurers typically represent the combined experience of multiple primary insurers. While some of these primary insurers may be experiencing change, the change is likely different from one insurer to the next. For example, one insurer may be experiencing a shift in case reserve adequacy due to procedures implemented by a new leader, while another insurer may be experiencing change in the settlement pattern related to the implementation of claims modernization initiatives that include use of drones, robotics, and digital technologies. Thus, it is important that reinsurance actuaries strive to have open lines of communication with their reinsureds to understand how changing environments could influence ceded claims.

For primary insurers working in environments of change, it is also important to consider if the effects of change (due to internal or external forces) could have different effects on claims at different layers, particularly between retained and ceded claims. Typically, such would be reflected in qualitative and judgment adjustments instead of the quantitative adjustments achieved through the Berquist-Sherman techniques.

CHAPTER 20

IMPACT OF CHANGING CONDITIONS ON PROJECTION METHODS

SUPPLEMENT MATERIAL

20.5 FURTHER DISCUSSION OF CHANGING CONDITIONS

This section contains more detailed discussions of the implications to projections of ultimate claims when there are changes in:

- Policy limits;
- Coverage triggers;
- Judicial decisions;
- Policy terms and conditions, endorsements and exclusions;
- Attachment points; and
- Reinsurance reinstatement provisions.

This section also discusses the actuary's obligation to analyze the effect on claims experience from underwriting changes, specifically changes in: classifications, underwriting variables, underwriting guidelines, growth, target markets, profitability, staffing, and programs.

When faced with a changing environment, the actuary should consider each of the seven questions suggested by Berquist and Sherman as well as their four suggestions for choosing data that are relatively unaffected by the specific problem. The actuary should also recognize the increased uncertainty in estimating unpaid claims in an environment of change and communicate such uncertainty with stakeholders.

20.5.1 POLICY LIMITS

Shifts in policy limits can arise for several reasons. Demands from policyholders that are related to economic and judicial considerations can lead to changes in policy limits. For example, as a company grows, which can arise from expanded markets or new product offerings, management may determine that increased policy limits are key to an effective risk management program. Judicial decisions that expand liability can influence companies to increase policy limits to ensure that they are adequately protected.

For personal automobile insurance, regulatory action can result in required changes to policy limits for TPL coverage or first-person no-fault limits (referred to as PIP in the U.S. and AB in Canada). For example, there were significant changes in Ontario, Canada on June 1, 2016 in the policy limits for AB coverage under the standard automobile insurance policy; Table 20.23 summarizes these changes.

Table 20.23

Summary of Change in Policy Limits in Ontario Personal Auto
Effective June 1, 2016

Policy Limit	Prior to June 1, 2016	After June 1, 2016
Medical and rehabilitation for non-catastrophic injuries	$50,000	Combined and reduced to $65,000 total
Attendant care for non-catastrophic injuries	$36,000	
Medical and rehabilitation for catastrophic injuries	$1 Million	Combined and reduced to $1 Million total
Attendant care for catastrophic injuries	$1 Million	

Actuaries projecting Ontario auto ultimate claims could reasonably expect that decreases in policy limits would lead to reduced severity of claims. As described in Chapter 14, claims at lower limits often take shorter times to be reported and settled than claims at higher limits. Similarly, severity trends associated with claims at lower limits are generally less than severity trends for claims at higher limits. Thus, changes in policy limits can have a significant effect on key actuarial factors used in the projection of ultimate claims and the estimation of unpaid claims. Depending on the magnitude of change in policy limits, the actuary may need to consider the number and total value of claims that were at the historical limit and adjust the analysis, either quantitatively or qualitatively, to reflect the new environment.

The actuary would consider:

- Whether the shift in limits was a gradual change over time or a sudden shift at an effective date, which can occur with changes in regulated automobile insurance;
- The magnitude of the change and the number of counts and volume of claim dollars potentially affected by the shift in limits; and
- The effect of the change in limits on exposures, particularly where earned premium is used as an exposure base.

20.5.2 COVERAGE TRIGGER

Coverage trigger is defined by IRMI as:

> The event that must occur before a particular liability policy applies to a given loss. Under an occurrence policy, the occurrence of injury or damage is the trigger; liability will be covered under that policy if the injury or damage occurred during the policy period.[7]

For some accidents, the coverage trigger is clear. For example, when an insured policyholder has an automobile accident that results in damage to the vehicles involved and injuries to the people in the car, the coverage trigger is the automobile accident. The determination of the coverage trigger can be complicated in situations where property damage or personal injury

[7] https://www.irmi.com/term/insurance-definitions/coverage-trigger April 26, 2019

arises over an extended period, such as environmental, abuse, asbestos, tobacco, and construction defect.

There are four generally accepted trigger of coverage theories: exposure, manifestation, injury-in-fact, and continuous trigger.

- Exposure theory – All CGL policies are triggered if they are in effect during exposure to injurious or harmful conditions. Primarily used in asbestos cases, this theory considers bodily injury to begin when a person was first exposed to asbestos, usually at the first inhalation of asbestos fibers.

- Manifestation theory – The CGL policy is triggered when the injury or damage is discovered or manifests itself (or in some cases is capable of being discovered) during the policy period. That the injury or damage may be been occurring prior to discovery may not be taken into account in this theory.

- Injury-in-fact theory – All CGL policies are triggered if they are in effect during the time the injury or damage is shown to have actually taken place, even if the injury or damage continues over time.

- Continuous trigger theory – All CGL policies are triggered if they are in effect during any of the following times: exposure to harmful conditions; actual injury or damage; and upon manifestation of the injury or damage.[8]

Different jurisdictions apply different coverage trigger theories; and even within a single jurisdiction, the trigger theory may differ for PD and BI liability. It is important for the actuary to understand the applicable law to the extent that changes in the coverage trigger have implications to the projection of ultimate claims. Changes in coverage trigger could lead to changes in: reporting and settlement patterns for claims and counts, frequency and severity, and trend factors.

For many of the GL exposures that would be most affected by shifts in the coverage trigger (such as tobacco, asbestos, abuse, and environmental claims), it is important to note that actuaries tend to use methods that differ significantly from the development method and other methods that rely on the selected development pattern. Actuaries may rely on modified frequency and severity methods as well as a survival ratio method, where an estimated value of calendar year payment is multiplied by the expected number of calendar years for which payments will be made.

20.5.3 JUDICIAL DECISIONS

As noted repeatedly in previous sections, judicial decisions can also result in an environment where the future is different from the past. For example, on September 15, 2016, the Supreme Court of Canada issued a decision on Ledcor Construction Limited (Ledcor) v. Northbridge Indemnity Insurance Company, which addressed the issues of interpretation and application of the standard “faulty workmanship” exclusions in commercial all risks insurance policies.

[8] IRMI on line - https://www.irmi.com/articles/expert-commentary/trigger-theories-and-the-cgl

The court decision expanded the scope of coverage available under a commercial all risk policy even in cases of faulty or improper workmanship. In *Supreme Court of Canada provides guidance on "faulty workmanship" exclusions in all-risk insurance policies*, Alexander Hlburn Beaudin + Lang LLP write:

> While the Supreme Court decision brings greater certainty to an unsettled area of the law, it will have significant implications for both insureds and insurers going forward …
>
> As a practical matter, the effect of *Ledcor* will be to broaden coverage under all-risk policies, even in situations involving faulty workmanship or design. If insurers wish to exclude any damage that is in any way causally connected to faulty workmanship or faulty design, they will have to use clear language to that effect in the policy, or perhaps modify the wording of the exception providing coverage for resulting damage.
>
> For their part, insureds under all-risk policies may wish to consider structuring their contractual arrangements to ensure that any work that poses a significant risk of causing damage to other parts of the project is subject to separate, discrete sub-contracts. The Supreme Court of Canada expressly noted in *Ledcor* that had the window cleaning company been responsible for installing the windows in good condition, as opposed to merely cleaning them, damage to the windows themselves during the installation process would have been excluded. It is possible, therefore, that coverage may depend at least in part on the scope of the insured's work as defined by contract, and so insureds will want to give some thought as to whether there is a practical way to structure their contractual arrangements on a given project in order to minimize the application of the 'faulty workmanship' exclusion and thereby maximize potential coverage.[9]

This decision was issued two weeks before the September 30 quarter-end. Thus, for actuaries working with Canadian insurers with significant portfolios of commercial all risk insurance, it was important to immediately gain an understanding of the decision and its potential implications for unpaid claims (including case estimates and IBNR) as well as any potential for claims that could reopen. In these circumstances, actuaries should have met with claims leaders and underwriters knowledgeable about these types of insureds. One potential approach for estimating unpaid claims at September 30, 2016 was to estimate values for additional frequency and severity related to the expanded coverage. For the year-end 2016 analysis, the actuary would have likely had more time to fully investigate the effect of the decision on the company's book of business and determine appropriate adjustments or new methods for the estimation of unpaid claims.

[9] https://insurancelawblog.ahbl.ca/2016/09/19/supreme-court-of-canada-provides-guidance-on-faulty-workmanship-exclusions-in-all-risk-insurance-policies/, accessed February 25, 2019.

The implications of this type of judicial decision are not isolated to actuaries working in the financial reporting area but also those involved in pricing. It is not uncommon that insurance rates increase following unintended expansions of coverage from judicial decisions.

20.5.4 POLICY TERMS AND CONDITIONS, ENDORSEMENTS AND EXCLUSIONS

Insurance policies are often adjusted to reflect changes in consumers' demands. For example, there has been a significant increase in personal property coverage for flood in Canada following the devastating floods in Alberta and Ontario during the summer of 2013. In contrast, following the tragic forest fires in California in the summers of 2017 and 2018, many insurers are modifying their property policies to exclude this peril. Another recent change to personal property policies is expansion of coverage when homes are rented, for example with Airbnb and other home-sharing platforms.

These types of changes, whether through modifications to the policy terms and conditions or through endorsements and exclusions to the policy, can have significant effects on future claims. Recall the two primary assumptions of the development method:

- Historical experience is predictive of future experience; and
- Activity observed to date is relevant for projecting future activity.

To the extent that development patterns are used by other methods, including the Bornhuetter Ferguson and Cape Cod methods, the above assumptions are critical to these methods as well. These assumptions may no longer hold when there are significant changes in policy terms and conditions or changes in endorsements and exclusions. Thus, the actuary would need to incorporate appropriate modifications to the analysis. Such modifications may include an adjustment factor similar to the reform factor discussed in Chapter 17 for regulatory change to the automobile product. Essentially, the actuary is attempting to modify historical experience to the same state as the current portfolio.

20.5.5 ATTACHMENT POINTS

An attachment point is the dollar value at which excess insurance or reinsurance coverage applies. For example, a primary insurer may purchase excess insurance for its automobile TPL and GL books of business with an attachment point of 1 million per occurrence. The insurer may also buy reinsurance coverage for its property portfolios (personal and commercial) with an attachment point of 2 million per claim. When primary insurers determine the attachment point at which they seek excess insurance and reinsurance protection, there are numerous considerations including but not limited to: recent claims experience (of the insurer and the industry), anticipated changes in their portfolio (which may be a result of recent merger or acquisition activity), their risk appetite, and the underwriting cycle (e.g., soft or hard market). Reinsurers also examine these issues when they decide the attachment points that they want to offer insurers.

Like changes in policy limits, changes in attachment points can have a significant effect on the claims experience. Increasing the attachment point for excess or reinsurance coverage could have a similar effect as that described for increasing policy limits, with longer reporting and settlement development patterns, higher severity values, and higher trends underlying the severity. Conversely, decreasing the attachment point (e.g., a change from a 2 million

attachment point to a 1.5 million attachment point) could lead to shorter reporting and payment patterns on a net of reinsurance basis and lower net of reinsurance severity. The actuary would consider whether the change in attachment points led to a violation of the underlying assumption that the future can be estimated based on historical experience. If this fundamental assumption no longer holds following the change in attachment point, then adjustments, quantitative or qualitative, would be required for the actuarial estimation of ultimate claims.

20.5.6 REINSURANCE REINSTATEMENT PROVISION

Reinsurance policy contracts often offer reinstatement provisions in which the coverage becomes effective following a full limit occurrence. This is particularly important for insurers who are faced with catastrophic losses early in the policy year. The option to reinstate the coverage may be included in the original premium or may be offered at an additional cost.

For example, many Canadian insurers opted to reinstate their reinsurance protection following the June 2013 catastrophic floods in Alberta. Given the extreme floods that occurred in Ontario in July 2013, this proved to be a critical decision for many insurers. In December of 2013, there was a catastrophic ice storm in Ontario. More insurers in December would have debated the value of reinstating their reinsurance protection (if it was not automatically provided for in the terms and conditions) given how close that event was to the January 1 renewal date. In Canada, with significant earthquake exposure in British Columbia as well as elsewhere in the country, the reinstatement of property reinsurance is particularly important.

Other jurisdictions around the world face similar situations as Canada. The official Atlantic hurricane season starts on June 1 and ends November 30. There are numerous examples over the past twenty years of multiple large hurricanes making landfall in the U.S. in the same calendar year including 2005 (Hurricanes Katrina in August, Rita in September, and Wilma in October) and 2012 (Hurricanes Isaac in August and Sandy in October). Bushfires in Australia and wildfires in the western U.S. and Canada can result in multiple catastrophic losses for insurers.

While a reinstatement of reinsurance coverage following a catastrophic event can be vitally important for an insurer, it can result in a distortion of historical experience for both exposures (particularly earned premium) and claims. Reinstatement premium, which is often considered earned immediately, is a ceded value and thus reduces the net earned premium for the primary insurer. Where a catastrophic event has occurred, the claims net of reinsurance will be unusually high (due to the catastrophe), and the net earned premium will be even lower than usual due to the additional ceded reinstatement premium. The comparison on a net of reinsurance basis could appear distorted for years in which the limit is breached, and reinstatement premiums are paid when compared to years in which no reinstatement is paid. Similarly, claims net of reinsurance could be higher for a year in which the reinsurance limits were available more than once. The actuary needs to carefully review development patterns, expected claims ratios, as well as expected frequency and severity values when estimating ultimate claims for a coverage and time frame for which reinstated reinsurance is applicable.

20.5.7 UNDERWRITING CHANGES

A critical question for the actuary when faced with underwriting changes is whether or not the changes would invalidate the underlying assumptions of a particular projection method. The

critical assumption of most of the methods described in this textbook is that historical relationships are predictive of future experience – either in the rate of claims development or relationships between claims (or counts) and exposures.

Changes in rating classifications, underwriting variables, and underwriting guidelines can have dramatic changes to an insurer's book of business with the potential for relationships in the future that differ from the past. Similarly, growth in certain markets or regions and shifts in target markets can lead to a current portfolio that is different from the historical portfolio with future claims experience that cannot be directly projected from the past. Finally, changes in underwriting staffing and underwriting processes (including the introduction of digital applications, robotics, and offshoring) can result in significant changes in an insurer's book of business such that the actuary should question the value of historical experience. All of the assumptions that underlie each projection method (e.g., development patterns, trends, and a priori expected claims ratios, frequency, and severity values) may need to be revisited and adjusted, either quantitatively or qualitatively, by the actuary. Documentation explaining the changes as well as the actuary's reaction to the change is critically important.

There is an extensive discussion in Chapter 5 about the actuary's need to seek qualitative information about the insurer and its environment when conducting an analysis of ultimate claims. Standards of practice from Australia and India are used to demonstrate good practice for the actuary, particularly with respect to changes in underwriting. Insurers continually strive to meet their customers' demands, which evolve over time as new technologies and behaviors emerge that change the risks that insureds want to address through insurance. For example, recent trends in the sharing economy, with homes, vehicles, and even electric scooters, have the potential to significantly change insurance products, policy terms and conditions, and underwriting procedures.

Furthermore, insurers frequently implement new approaches that are targeted at improving efficiency and incorporating new technology. For example, insurers are increasingly turning to big data and predictive analytics as well as robotic process automation. These technologies are being used in areas such as marketing, underwriting and policy issuance, detection of claims fraud, and pricing and segmentation. Insurers are increasing their use of data visualization and business intelligence software to better analyze profitability and direct their efforts at growth and target markets. Many insurers have implemented lean management processes[10] across numerous functional areas, particularly underwriting, claims, and finance.

Chapter 5 opens with the comments:

> In conducting actuarial work, actuaries rely on historical data to project future claims. The fundamental assumption underlying most actuarial analyses is that patterns and relationships evident in historical data will be predictive of the future. To validate this critical assumption, actuaries seek information

[10] Lean management refers to a technique developed with the aim of minimizing the process waste and maximizing the value of the product or service to the customer, without compromising the quality. Source: https://businessjargons.com/lean-management.html

> about the organization and the environments in which the organization operates.

To the extent that an insurer's operations change, whether related to new and emerging technologies or other drivers, the actuary is obligated to consider whether the historical experience is still relevant for projecting future experience. When there are questions about the relevance of historical experience, the actuary would seek to supplement the data with alternative data sources or strive to incorporate adjustments, either quantitatively or qualitatively, to the historical data. It is critical that the actuary clearly document the reasons why alternative data are more appropriate as well as any adjustments that are made to historical experience. See Chapter 8 for further information about documentation.

When significant changes are made to the data or processes related to changes in underwriting and company operations, it is can also be important for the actuary to have a peer review conducted. The Institute and Faculty of Actuaries' *Peer Review Guide, Guidance for APS X2: Actuarial Quality and Peer Review*, by the Regulation Board, states:

> 1.1 Peer review is one of a number of means that professionals use to maintain the quality of the work that they perform. Actuaries have developed a practice of making significant use of peer review in their work. This serves to provide reassurance to actuaries and the users of actuarial work that the work has been performed to relevant technical and ethical standards, and in so doing to reduce the risk that users of actuarial work make poor decisions as a consequence of the actuarial work.
>
> 1.2. What is peer review? At its simplest, peer review is the use of a second pair of eyes to review and challenge some or all of the work of the person who performed that work. More generally, peer review provides a mechanism to test work and the decisions taken. Peer Review is defined in APS X2 Actuarial Quality and Peer Review (APS X2) as a:
>
> "Process by which a piece of work (or one or more parts of a piece of work) for which a Member is responsible is considered by at least one other individual(s), having appropriate experience and expertise, for the purpose of providing assurance as to the quality of the work in question."[11]

The role of peer review is also addressed by the IAA in ISAP 1:

> The actuary should consider to what extent, if at all, it is appropriate for any report to be independently reviewed, in totality or by component, before the final report is delivered to the principal or distributed to the intended users. The purpose of peer review is to ensure the quality of the report, with the process tailored to the complexity of the work and the specific environment in which the actuary works. (International Actuarial Association, 2012)

[11] https://www.actuaries.org.uk/documents/actuarial-quality-and-peer-review-draft-guide, accessed February 25, 2019.

APPENDICES

APPENDICES H AND I

SUPPLEMENT MATERIAL

APPENDIX H

A REINSURANCE PRIMER

SUPPLEMENT MATERIAL

Key Learning Objectives for Appendix H

- Introduce reinsurance and key reinsurance terms;
- Describe the principal functions of reinsurance;
- Identify and describe the types of reinsurance; and
- Highlight important reinsurance contract terms that have the potential to affect actuarial work.

Important Terminology Introduced in Appendix H

- Primary insurer, direct insurer
- Ceding company, cedent, reinsured
- Cedes
- Assumes
- Retention
- Limit
- Attachment point
- Retrocession
- Retrocedent
- Retrocessionaire
- Subscription
- Portfolio reinsurance
- Treaty
- Facultative
- Pro rata
- Excess of loss
- Quota share
- Surplus share
- Ceding commission
- Aggregate stop loss
- Financial reinsurance
- Finite risk reinsurance
- Risk-attaching, policies-attaching
- Loss-occurring
- Reinstatement
- Reinstatement premium
- Annual aggregate deductible
- Loss ratio corridor

- Loss ratio cap
- Index clause

H.0 IMPORTANCE OF UNDERSTANDING THE EFFECT OF REINSURANCE

As noted previously, this textbook is not intended for use specifically by reinsurance actuaries. That said, understanding reinsurance is critically important for the actuarial work of primary insurers. The presence (or absence) of reinsurance and the changes in reinsurance terms and conditions over time can greatly affect an insurer's data as well as the appropriateness of actuarial assumptions and methodologies. Thus, the purpose of this chapter is to cover reinsurance terms and concepts that are important for an actuary to understand.

H.1 REINSURANCE DEFINED: INSURANCE FOR INSURERS

Reinsurance is commonly referred to as insurance for insurers. In a reinsurance transaction, the insured is an insurer who is buying an insurance policy from another insurer, the reinsurer. The main purpose of reinsurance is to transfer an insurer's risk or part of its risk to the reinsurer(s) resulting in a further spread of the risk. As with insurance, reinsurance is also a contract to pay possible future claims in return for a payment, the reinsurance premium.

It is important to recognize that a reinsurance contract does not alter the terms of the underlying (original) insurance policy or the primary insurer's obligation to honor its policy. In *Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance*, Robert L. Brown and Leon R. Gottlieb state: "The obligation of the primary insurer that originally issued the policy is not transferred to the reinsurer, but the primary insurer will call upon the reinsurer to reimburse it for all payments subject to the terms of the reinsurance contract." (Brown & Gottlieb, 2007)

The majority of reinsurance purchasers are primary insurers, from all classes of insurance, both life and general insurance. Captive insurers are also frequent purchasers of reinsurance. Many self-insurers purchase excess of loss insurance, which is described in this chapter.

H.2 KEY REINSURANCE TERMS

Reinsurance terminology often refers to the original insurance company as the **primary insurer** or **direct insurer**. The primary insurer is also known as the**: ceding company**, **cedent,** or **reinsured**. An insurer can be both a primary insurer and a reinsurer.

The primary insurer **cedes** (or transfers), and the reinsurer **assumes** part or all (not common) of the original risk. The **retention** is the amount of insurance risk that the primary insurer keeps for its own account. The retention can be expressed as a percentage of the original amount of insurance or as a dollar amount. The retention can also be referred to as the primary insurer's **limit** or the reinsurer's **attachment point**.

Similar to insurers seeking risk transfer, reinsurers may also transfer part of their liability through reinsurance agreements with other reinsurers. Such a transaction between reinsurers is known as a **retrocession**. Under a retrocession, one reinsurer (the **retrocedent**) transfers part or all of the reinsurance risk that it has assumed or will assume to another reinsurer (the **retrocessionaire**) in exchange for a premium. Frequently, reinsurance is written on a

subscription basis where multiple reinsurers will share the risk; reinsurers generally participate on a percentage basis for specified layers. At times, primary insurers will participate in various layers, essentially co-insuring the risk.

H.3 PRINCIPAL FUNCTIONS OF REINSURANCE

There are six principal functions of reinsurance:

- Increase capacity;
- Provide catastrophe protection;
- Stabilize claims experience;
- Offer technical service and expertise;
- Strengthen primary insurer's financial position and provide capital relief; and
- Facilitate withdrawal from a market segment.

H.3.1 INCREASE CAPACITY

A primary insurer's capacity for writing greater limits is influenced by: insurance regulations; the potential effect of large claims on earnings or policyholders' surplus; specific characteristics of a particular exposure; and the amount, types, and cost of available reinsurance. Reinsurers allow primary insurers to increase their capacity by accepting risk that the primary insurer is unwilling or unable to retain on its own. Thus, reinsurance enables the primary company to write larger amounts or higher limits of insurance coverage.

H.3.2 PROVIDE CATASTROPHE PROTECTION

The purpose of catastrophe protection is to prevent the destabilization of a primary insurer's underwriting results from the effect of a single catastrophic event, either natural (such as a hurricane or earthquake) or other (industrial explosions, terrorism, aviation, etc.). Without reinsurance, a catastrophe could greatly reduce the insurer's earnings and potentially threaten its solvency. There is a close relationship between the purchase of catastrophe coverage and the stabilization function.

H.3.3 STABILIZE CLAIMS EXPERIENCE

Reinsurance serves to prevent the destabilization of a primary insurer's underwriting results from the effect of non-catastrophic events, such as an unusually large accumulation of routine claims. The variability in an insurer's claims experience from year to year can lead to volatility in its financial results. Such volatility can: affect the stock value of a company; alter the insurer's financial rating(s); result in changes in underwriting, claims management, or sales; and possibly even lead to insolvency. Insurers can stabilize their claims experience by limiting their liability for a single claim, for multiple claims, or for the aggregate of all claims over a period of time.

H.3.4 OFFER TECHNICAL SERVICE AND EXPERTISE

Working with many primary insurers across a wide variety of business lines allows reinsurers to accumulate vast amounts of knowledge. Primary insurers can benefit from the reinsurer's expertise in a wide range of areas including: product development, pricing and underwriting, and claims management. Reinsurers' expertise can be particularly valuable to insurers when

they are developing new products or entering new markets. Primary insurers can rely on the expertise of reinsurers for entire portfolios of business, segments of portfolios (such as a specific geographical region or industry classification), or even a single account.

H.3.5 STRENGTHEN PRIMARY INSURER'S FINANCIAL POSITION AND PROVIDE CAPITAL RELIEF

Reinsurance can provide capital relief and flexible financing for primary insurers. The financial position of a primary insurance company can be strengthened due to the effect of reinsurance accounting. By purchasing reinsurance coverage, a primary insurer transfers risk to the reinsurer and consequently does not need to allocate capital for this risk. The ability to assume more risks, at the same level of capital, means that primary insurers can spread their overhead expenses over a broader base and thereby benefit from economies of scale.

H.3.6 FACILITATE WITHDRAWAL FROM A MARKET SEGMENT

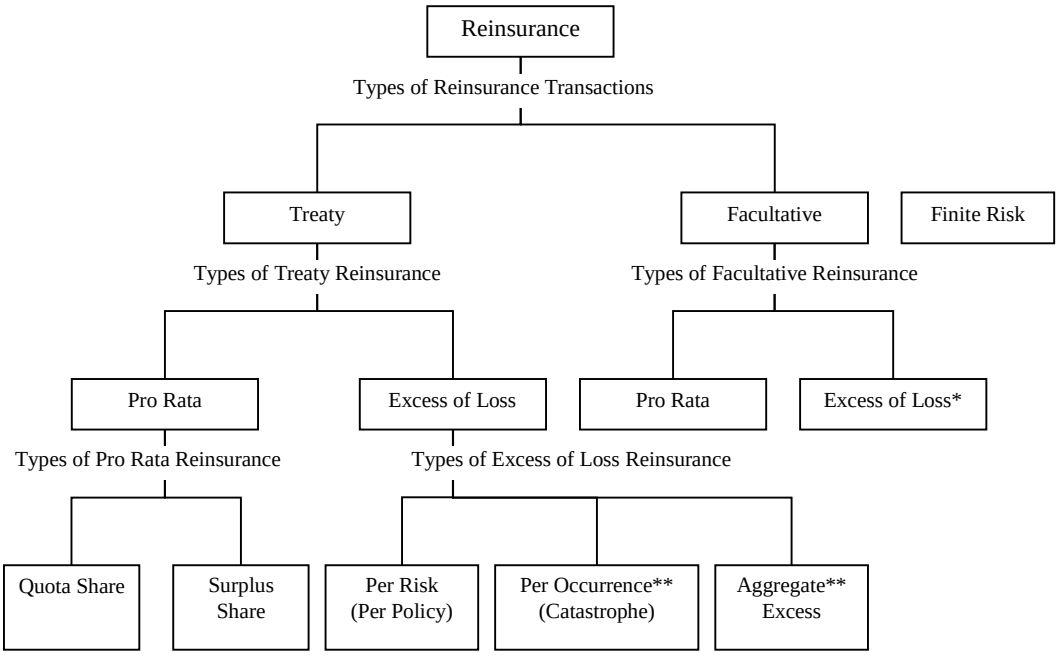
A primary insurer may want to withdraw entirely from a particular risk, line of business, or region that is either unprofitable, undesirable, or no longer fits into its strategic plan. **Portfolio reinsurance**, which is used to reinsure the underlying contracts of an entire type of insurance, class of business, or geographic area, can facilitate a primary insurer's withdrawal from a market segment. In portfolio reinsurance, the reinsurer[12] accepts all the liability for certain claims covered by the primary insurer's policies. As noted previously, the primary insurer must continue to fulfill its obligations to its insureds and seek reimbursement from the reinsurer.

H.4 TYPES OF REINSURANCE

As described previously, primary insurers generally purchase reinsurance for several reasons, including balance sheet protection and capital relief. When purchasing reinsurance, a primary insurer often makes use of the range of forms and types of reinsurance available. Traditional reinsurance is essentially a contract to accept a cedent's risks in return for the payment of a reinsurance premium. There are two typical ways to classify traditional reinsurance contracts. First, the type of transaction determines whether a contract is categorized as a **treaty** or as a **facultative** reinsurance arrangement. This contract can then be further categorized based on the manner in which the insurer and the reinsurer share the risk: **pro rata** (proportional sharing) or **excess of loss** (nonproportional sharing). In *Reinsurance Principles and Practices*, Connor M. Harrison summarizes the types of reinsurance and their relationships as outlined in Figure H.1. (Harrison, 2004)

[12] References to a single reinsurer can also apply to multiple reinsurers who participate through subscription in a specific reinsurance arrangement with a primary insurer.

Figure H.1 Types of Reinsurance[13]



*Excess of loss reinsurance written on a facultative basis is always on a per risk or per policy basis.

**Per occurrence and aggregate excess of loss reinsurance relate to a type of insurance, a territory, or the primary insurer's entire portfolio of in-force loss exposures rather than to a specific policy or a specific loss exposure.

H.4.1 TREATY AND FACULTATIVE REINSURANCE

In a treaty reinsurance arrangement, the primary insurer and reinsurer[14] agree in advance which line(s) of business will be ceded to the reinsurer according to the terms of the contract. The treaty reinsurance contract can include standard terms, manuscript terms (i.e., custom designed for a particular risk), or a combination. All of the primary insurer's individual insurance contracts that fall within the treaty are automatically reinsured. This type of reinsurance contract involves an ongoing relationship between the primary insurer and reinsurer. Treaty reinsurance is common when a group of homogeneous risks are being insured; treaty reinsurance is dominant in both life and general reinsurance. As long as the terms of the treaty are met, the primary insurer is obliged to cede the business and the reinsurer is obliged to assume the business. As a result, another name for treaty reinsurance is obligatory reinsurance.

Facultative reinsurance differs from treaty reinsurance in that it is non-obligatory. Facultative agreements insure individual underlying (i.e., primary) insurance contracts; the reinsurer underwrites each insurance contract separately. The primary insurer chooses which contracts to submit to the reinsurer, and the reinsurer can accept or reject any insurance contract

[13] Copyright, The Institutes, used with permission.

[14] As noted previously, a reference to a single reinsurer could also refer to a group of reinsurers each taking a percentage of the reinsurance agreement, not to exceed 100% in total. This comment is applicable to all types of reinsurance described in this chapter.

submitted. Facultative arrangements are common for risks that involve large limits and are heterogeneous in nature. Facultative reinsurance contracts frequently incorporate the standard policy terms and conditions of the insurance contracts issued by the primary insurer.

H.4.2 PRO RATA REINSURANCE

The common characteristic of pro rata (or proportional) reinsurance is that both the primary insurer and the reinsurer proportionately share the amounts of insurance, the policy premiums, and the insured claims. Pro rata reinsurance is usually categorized as **quota share** or **surplus share**.

Under quota share reinsurance, the primary insurer and reinsurer share the amounts of insurance, policy premiums, and claims using a fixed percentage. This fixed percentage of premium and claims sharing by both parties is from the "ground up" (i.e., from first dollar claims) and applies to all risks subject to the quota share agreement. Quota share reinsurance can be used with both property and liability insurance, although it is more commonly used with property insurance.

Surplus share reinsurance is a variation of quota share, with the shared percentage varying by type of risk and policy limit. Once a risk of the specified type is insured for a policy limit that exceeds the primary insurer's selected net retention, the reinsurer's participation commences and operates just as it would under a quota share agreement (i.e., the entire risk is shared proportionally as to premiums and claims). As an example, consider a surplus share contract with a net retention of 500,000 and a share percentage of 50%. For any claim that exceeds 500,000, the primary insurer would retain the first 500,000, and the primary insurer and the reinsurer would equally share the amount of the claim exceeding 500,000. There would be no recovery for claims less than 500,000. The distinguishing factor in surplus share reinsurance is that coverage only applies to those policies whose amount of insurance exceeds a minimum dollar amount (the insurer's maximum net retention). Surplus share reinsurance is typically used for property lines of business only.

With pro rata reinsurance, the primary insurer cedes a portion of the original insurance premium to the reinsurer as reinsurance premium. The reinsurer usually pays a **ceding commission** to the primary insurer to compensate the primary insurer for policy acquisition expenses that were incurred when the policy was sold. The reinsurance agreement may also include a negotiated profit-sharing commission (also called profit commission or contingent commission), which is paid to the primary insurer after the end of the treaty year if the reinsurer earns greater-than-expected profits on the reinsurance agreement.

When considering the six principal functions of reinsurance, proportional reinsurance best addresses increased capacity and enhanced financial strength for the primary insurer.

H.4.3 EXCESS OF LOSS REINSURANCE

Under excess of loss reinsurance arrangements (also known as non-proportional reinsurance), the reinsurer indemnifies the primary insurer for claims that exceed a specified dollar amount. The common characteristic of all types of excess of loss reinsurance is that the reinsurer responds to a claim only when the claim amount exceeds a specified dollar amount, known as the attachment point (also referred to as retention or limit).

In *Reinsurance Principles and Practices*, Connor M. Harrison identifies five major types of excess of loss reinsurance:

- Per risk excess of loss: The reinsurance limit and the retention apply per risk rather than per accident, per event, or in the aggregate. Per risk excess of loss typically covers property insurance and applies separately to each loss occurring to each risk.

- Catastrophe excess of loss: This type of reinsurance protects the primary insurer from an accumulation of retained claims that arise from a single catastrophic event.

- Per policy excess of loss: The attachment point and the reinsurance limit apply separately to each insurance policy issued by the primary insurer regardless of the number of claims occurring under each policy.

- Per occurrence excess of loss: The attachment point and the reinsurance limit apply to the total claims arising from a single event (or occurrence) affecting one or more of the primary insurer's policies.

- Aggregate excess of loss (also referred to as stop-loss and aggregate stop-loss): The reinsurer participates over a predetermined aggregate limit for a collection of risks over a specified period (usually one year). (Harrison, 2004)

The different types of excess of loss reinsurance generally have a specific use. Per risk and catastrophe excess of loss are usually used for property lines of business. Per policy and per occurrence excess of loss are usually used for liability lines of business. Aggregate excess of loss reinsurance is used for both property and liability lines of business.

When considering the six principal functions of reinsurance, excess of loss reinsurance best addresses increased capacity, catastrophe protection, and stabilized loss experience.

H.4.4 AGGREGATE EXCESS OF LOSS

With an **aggregate excess of loss** (or **stop-loss)** reinsurance contract, the ceding insurer transfers all claims over a specified amount, which may be expressed as a dollar value or an agreed percentage of some other business measure, to the reinsurer. Aggregate stop-loss can be very expensive for insurers and is thus not commonly used today. This type of reinsurance is used more frequently with captive insurers, self-insurance funds, and large deductible programs. With aggregate stop-loss coverage, a reinsurer assumes all claims in excess of the attachment point, thus capping the annual claims of the cedent. It is important that the actuary is aware of an aggregate stop-loss coverage as such reinsurance protection can have a significant influence on the development of ultimate claims that are used for reserving and pricing purposes.

H.4.5 FINANCIAL (OR FINITE) REINSURANCE

In the 1980s, rising insurance costs and reduced availability of traditional reinsurance resulted in an expansion of alternatives to traditional reinsurance. These more customized risk transfer methods are broadly referred to as alternative risk transfer and are a distinct class unlike

traditional reinsurance. Alternative risk transfer strategies include the use of captives and **financial reinsurance**.

Financial reinsurance emerged as an innovative product in the 1980s; it is also referred to as **finite risk reinsurance**. Generally, the reinsured pays a premium that constitutes a pool of funds for the reinsurer to pay claims. If claims are lower than the premium, the reinsurer returns some or all of the premium to the reinsured; if claims exceed the premium, the reinsured pays additional premium to the reinsurer. While the primary purpose of traditional reinsurance is the minimization or spreading of risk, the motivation for financial reinsurance is more closely linked to an investment decision. Many observers believe that finite and financial reinsurance policies represent a capital infusion, making them more like a loan than an insurance policy, and should be treated as such from an accounting and regulatory standpoint. In finite risk reinsurance transactions, the primary objective is often related to improving the primary insurer's reported financial results and/or financial position with a limited amount of risk transferred between the primary insurer and the reinsurer.

Much controversy arose regarding finite risk reinsurance arrangements. In a Fitch Ratings Special Report titled "Finite Risk Reinsurance" (Fitch Ratings Special Report, 2004), insurance analysts state that carriers are using finite reinsurance to improve short-term results, enhance capital, or smooth earnings from quarter to quarter, rather than to transfer risk. As a result, insurance regulations and solvency regulations direct attention and scrutiny to reinsurance transactions. This scrutiny is related to the potential to distort the balance sheet of both insurance companies and reinsurance companies through the use of finite risk reinsurance arrangements.

H.5 RISK-ATTACHING AND LOSS-OCCURRING REINSURANCE CONTRACTS

Reinsurance contracts can also be categorized as **risk-attaching** and **loss-occurring**. The distinction between these two describes which underlying insurance contracts are covered by a reinsurance contract.

In risk-attaching (also referred to as **policies-attaching**), the reinsurance contract covers all insurance contracts that are incepted during the reinsurance contract term. In a risk-attaching reinsurance contract, the "business-covered" clause might read:

> "This contract shall apply to all insurances relating to risks covered hereunder issued or renewed on and after (month, day, year)." Where the reinsurance contract provides that the "company binds itself to cede and the reinsurer agrees to accept a fixed proportion of __ percent of all business falling within the term of this agreement up to a limit of __."[15]

For example, a risk-attaching reinsurance contract that is effective from January 1, CY1 to December 31, CY1 covers a primary policy with a December 31, CY1 effective date even though claims arising from such policy could occur from January 1, CY2 to December 30,

[15] https://www.irmi.com/articles/expert-commentary/understanding-the-business-covered-clause, accessed January 27, 2019

CY2, which is after the reinsurance effective dates. Proportional reinsurance is often written on a risk-attaching basis.

In loss-occurring contracts, the reinsurance responds to claims arising from insured events during the reinsurance contract policy term. IRMI provides the following example of a loss-occurring-during clause: "This contract shall apply to losses occurring during the term of this contract and shall remain in force until (month, day, year)."[16]

For property insurance, the loss-occurring date is typically clear, because the event generally starts at a precise date. Exceptions can arise when an event, such as a flood or ice storm, continues from one reinsurance term to another, but contract provisions, such as the hours clause, typically address these types of situations. For liability insurance, the determination of a specific date of loss may be more problematic in situations such as employment liability where the personal injury may be related to long-term exposure to hazardous materials, such as asbestos.

It is important for the actuary to understand which reinsurance contracts are on a risk-attaching basis and which are loss-occurring not only to properly apply limits to claims but also to ensure that premium is accounted for correctly. For risk-attaching reinsurance, the premium is typically accounted for over two years. For loss-occurring reinsurance, the premium is typically earned over one year.

H.6 REINSURANCE CONTRACT TERMS AFFECTING ACTUARIAL WORK

It is beyond the scope of this textbook to include a comprehensive description of all reinsurance contract terms and conditions that have the potential to influence actuarial work. However, the following issues are addressed:

- Treatment of LAE;
- Reinsurance provisions;
- Claims-sensitive reinsurance features; and
- The index clause.

H.6.1 TREATMENT OF LAE

It is critically important that the actuary understands the treatment of LAE, both ALAE and ULAE, in reinsurance contracts and how such treatment may have changed over time. The actuary should know whether LAE are included in the insurer's retention and the reinsurer's limits and if so, how they are included. ALAE may be ceded on a pro rata basis in addition to the insurer's retained indemnity limit, or ALAE may be considered part of the insurer's retention.

For example, assume a primary insurer has a per occurrence excess of loss reinsurance contract for its GL portfolio with limits 5 million excess 2 million (i.e., the reinsurer assumes 5 million

[16] https://www.irmi.com/articles/expert-commentary/understanding-the-business-covered-clause, accessed January 27, 2019

limits excess of the primary insurer's 2 million retention). Further, assume a claim with 4 million indemnity and 500,000 ALAE.

- With pro rata treatment of ALAE, the primary insurer retains 2 million indemnity claim and 250,000 ALAE (2 million retained / 4 million total claim × 500,000 total ALAE), and cedes 2 million indemnity and 250,000 ALAE to the reinsurer.
- With ALAE within the retention, the primary insurer retains 2 million total indemnity and ALAE and cedes 2 million indemnity and 500,000 ALAE to the reinsurer.

Frequently, ALAE are outside of the reinsurance limit for per occurrence and per policy liability reinsurance contracts and included within the limits for property catastrophe contracts.

The actuary also needs to understand the treatment of LAE in any claims-sensitive reinsurance features (described later in this chapter). Proportional reinsurance usually includes both claims and ALAE; however, quota share treaties can have manuscript wording that provide for a different treatment of ALAE. Typically, though not always, ULAE is excluded from reinsurance contracts.

Unlike primary insurance contracts, reinsurance contracts are often tailor-made to meet the requirements of the insurer and the reinsurer reflecting market conditions at any point in time. Thus, it is important for the actuary to confirm the treatment of LAE at each reinsurance renewal. It is incumbent upon the actuary to understand reinsurance terms and conditions and any changes over time and to reflect such changes in the data, assumptions, and methodologies of actuarial work. The actuary should maintain comprehensive documentation of the insurer's reinsurance program by year and by coverage and the effect on actuarial work.

H.6.2 REINSTATEMENT PROVISIONS

Excess of loss reinsurance is a vital component of an insurer's risk management framework. Serious problems can arise for an insurer if its reinsurance protection is depleted, either due to a single event or multiple events, prior to the end of the reinsurance contract term. If an insurer reaches the limit of its reinsurance policy before the end of the reinsurance contract term, then the insurer is essentially without protection and must retain future claims on its own. This can be particularly problematic for property insurance, as catastrophic events can happen at many times of the year. In North America, for example, winters are known for ice storms; spring for floods; summers for tornados, hail, and wildfire; and the fall for hurricanes. Furthermore, an earthquake could happen at any time of year. Thus, insurers do not want to erode their reinsurance programs at any time of the year.

To address this situation, reinsurance contracts often allow for a **reinstatement**, which is a reset of the limit for the duration of the original reinsurance contract term. In some reinsurance contracts, the reset of the limit is automatic; and in other contracts, the restatement must be at the request of the primary insurer. Reinstatement provisions are common in property excess treaties.

H.6.3 CLAIMS-SENSITIVE REINSURANCE FEATURES

Reinsurance contracts can be structured so that the primary insurer's claims experience influences the ceded premium, ceding commissions, and ceded claims. Reinsurers use these

types of contract terms to allow a cedent to share in the ceded experience with the objective of motivating the insurer to be more highly vested in the results and to bridge gaps that may exist between the reinsurer's and primary insurer's estimates of claims. The actuary should be familiar with these features to the extent that they influence the insurer's claims and exposure data as well as the projections of ultimate values and reserves required for financial reporting.

Three common features that result in premiums varying based on claims experience are: reinstatement provisions, swing-rated contracts, and a bonus for being claims-free. Profit and sliding scale commissions result in ceding commission that varies based on claims experience. Finally, three reinsurance contract provisions that result in ceded claims that vary based on experience are: **annual aggregate deductibles (AAD)**, **loss ratio corridors**, and **loss ratio caps**. (Garrigan, 2009) Profit commission and loss ratio caps can be found in both pro rata and excess of loss reinsurance. Sliding scale commissions and loss corridors are also used in pro rata treaties; while reinstatements, swing-rating provisions, claims-free bonus, and annual aggregate deductibles can be found in excess of loss reinsurance.

H.6.4 ANNUAL AGGREGATE DEDUCTIBLE (AAD)

An AAD is a provision in an excess of loss reinsurance contract whereby the primary company retains an annual aggregate dollar value of claims that is in addition to its retention per risk or per occurrence. The AAD, which can be expressed as a dollar value or as a percentage of the ceding insurer's premium, limits the amount of claims the primary insurer may be required to pay before reinsurance protection begins.

For example, assume a primary insurer has a per risk excess of loss reinsurance contract with a 10 million excess 3 million limit (i.e., 10 million reinsurance coverage above the primary insurer's 3 million retention) and a 10 million AAD. Table H.1 presents how the claims would be retained and ceded for five claims.

Table H.1

First Example of AAD

Claim #	Ultimate Claim	Primary Insurer	Reinsurer
1	3,500,000	3,000,000	500,000
2	2,500,000	2,500,000	0
3	6,000,000	3,000,000	3,000,000
4	10,000,000	1,500,000	8,500,000
5	5,000,000		5,000,000

For claim #1, the reinsurer assumes 500,000, which is the amount of the claim that is excess of the primary insurer's 3 million per risk excess of loss retention. There is no reinsurance coverage for claim #2, because the claim did not exceed the primary insurer's per risk retention of 3 million. For claim #3, the primary company has its full 3 million retention, and the remaining 3 million is assumed by the reinsurer in accordance with the per risk excess. For claim #4, the primary insurer only retains 1.5 million because it has reached the AAD of 10 million (3 million from claim #1, 2.5 million from claim #2, 3 million from claim #3, and now 1.5 million from claim #4). The entire amount of claim #5 is thus ceded to the reinsurer under the AAD.

If the same insurer had the claims seen in Table H.2, the situation for the reinsurer would be very different.

Table H.2

Second Example of AAD

Claim #	Ultimate Claim	Primary Insurer	Reinsurer
1	1,000,000	1,000,000	0
2	1,000,000	1,000,000	0
3	1,000,000	1,000,000	0
4	1,000,000	1,000,000	0
5	1,000,000	1,000,000	0
6	1,000,000	1,000,000	0
7	1,000,000	1,000,000	0
8	1,000,000	1,000,000	0
9	1,000,000	1,000,000	0
10	1,000,000	1,000,000	0
11	1,000,000		1,000,000

In this second situation, the primary insurer still retains only 10 million in claims due to the AAD, but the cession to the reinsurer is far less as there are no claims greater than 3 million.

Many claims systems are limited in the reinsurance detail that they can maintain. As a result, reinsurance records are often kept on ancillary systems, which may not even be maintained by Claims but instead by the Finance or Reinsurance teams. It is vitally important that the actuary understands how claims in excess of the insurer's retention are handled in the claims management system, and where necessary, adjustments to claims data used for actuarial analyses may be required.

H.6.4.1 Loss Ratio Corridor

A loss ratio corridor is a reinsurance provision in which the ceding insurer retains claims that would otherwise be ceded to the reinsurance treaty. With a loss ratio corridor, the reinsurer pays a portion of the claims up to a specified amount, then the ceding insurer pays the claims in excess thereof up to a second specified amount, and then the reinsurer pays any remaining excess. For example, assume a primary insurer with an 80% to 90% loss ratio corridor that is 100% retained:

- If ceded claims resulted in a 75% ceded loss ratio, then all claims would be ceded to the reinsurer;
- If ceded claims resulted in an 80% ceded loss ratio, then all claims would be ceded to the reinsurer;
- If ceded claims resulted in an 85% ceded loss ratio, then claims up to 80% would be ceded and claims in the layer 5% excess of 80% would be retained by the primary insurer;

- If ceded claims resulted in an 90% ceded loss ratio, then claims up to 80% would be ceded and claims in the layer 10% excess of 80% would be retained by the primary insurer; and
- If ceded claims resulted in an 95% ceded loss ratio, then claims up to 80% would be ceded and claims in the layer 10% excess of 80% would be retained by the primary insurer, and the final 5% of claims in the layer excess 90% would be ceded to the reinsurer.

The participation in the loss ratio corridor can vary and be shared between the primary insurer and the reinsurer. Such a feature may be used when there are differing views as to the primary insurer's expected claims.

H.6.4.2 Loss Ratio Cap

A loss ratio cap in a reinsurance contract specifies the maximum claims ratio that can be ceded to the reinsurer. Once the ceded claims exceed this cap, no further claims can be ceded.

H.6.5 INDEX CLAUSE

IRMI defines the index clause as follows.

> An index clause, also referred to as an inflation clause, a stability clause, or an indexation clause, redistributes inflation-related increases in the costs of claims between the ceding insurer and its reinsurer. In most excess-of-loss contracts, the ceding insurer's retention and the reinsurance limit amounts are fixed dollar (or other currency) amounts, and the reinsurer's liability triggers at the point the retention is met. If neither the retention nor the limit is indexed, claim inflation can cause a loss to reach the retention amount sooner and more frequently than anticipated. Further, if there is greater inflation after the claim reaches the retention amount, the reinsurer's liability will not increase with the rising cost of the claim. The index clause achieves redistribution of these inflation-related increases by adjusting the retention and limit amounts of a reinsurance contract in accordance with an inflation index.[17]

In *Expert Commentary, Protect against Inflation with the Reinsurance Index Clause*, IRMI notes that the index clause has been widely used in Europe since the 1970s in excess of loss reinsurance contracts for auto liability, GL, and E&O liability risks. The index clause, however, has not been widely used in the U.S.[18]

H.7 CONCLUDING REMARKS

Whether the actuary works for a primary insurer or a reinsurer, it is important that he or she has sufficient understanding of the policies in force and the terms and conditions of such policies. The types of reinsurance policies held by a primary insurer as well as those sold and held by a reinsurer can have significant implications to the actuary's choice of data types,

[17] https://www.irmi.com/term/insurance-definitions/index-clause, accessed January 27, 2019
[18] https://www.irmi.com/articles/expert-commentary/reinsurance-index-clause, accessed January 27, 2019

aggregation of data, and selection of assumptions and methodologies. In particular, changes in the types of policies and their term can influence actuarial work.

APPENDIX I

DEVELOPMENT ANALYSIS FOR EXCESS LIMITS AND LAYERS

I.0 BACKGROUND

Actuaries working on behalf of primary insurers, either as internal company actuaries or as consulting actuaries, frequently have access to ground-up data. In Chapter 25 – Calculating Trend in Claims, "ground-up" is used to refer to the value of claims from the first dollar of loss, prior to the application of any deductible. It was noted in Chapter 25 that ground-up data are not always available to the insurer. Insureds frequently do not report losses that fall within their deductible to their insurer for fear of increased rates or even policy cancellation. Furthermore, the IT systems of some insurers may not have the capability to record the values of losses below policyholder deductibles nor the values of losses in excess of policy limits. The unavailability of ground-up data can be more pronounced for insurers who provide coverage excess of large deductibles or SIRs and also for reinsurers offering excess coverage.

The purpose of this appendix is to provide examples of approaches the actuary may follow for using a development projection method at alternative limits, particularly excess limits and excess layers. As noted repeatedly in this textbook, the actuary would generally be expected to use more than one method for projecting ultimate claims. Four approaches are presented in this appendix.

In Section 14.6.1 – Total Limits versus Limited Claims Data, the data from ten claims are used to demonstrate the effect on the development patterns of using limited claims data. Limiting claims for development purposes has the effect of shortening the development patterns as the ultimate values of limited claims are reached at earlier maturity ages than would be the case for total limits claims. It is important that actuaries understand and reflect the differences in age-to-age factors between claims:

- At limited values;
- At total limits;
- Excess of stated limits; and
- Within layers.

The differences may be examined based on actual data or assumed relationships derived from statistical models, simulation analysis, or professional judgment. Chapter 33 – Actuarial Pricing for Deductibles and Increased Limits contains important information not only for pricing but also for actuaries working in the reserving and financial reporting areas.

In some situations, the actuary will have access to sufficient and reliable data at alternative limits and can conduct development analysis based on the available data. At other times, the actuary may be required to approximate the relationships of data at various limits based on the

data that are available. Detailed examples of both situations are developed in this appendix using the claims data and analyses presented in Appendix A for Dentist Insurer and Appendix C for Homeowners Insurer.

I.1 APPROACHES FOR ESTIMATING DEVELOPMENT PATTERNS

As seen in Part 4 – Basic Methods for Estimating Ultimate Claims, development patterns are a key assumption for several projection methods, including the development, Bornhuetter-Ferguson, and Cape Cod methods. In this appendix, two approaches are used to estimate development patterns for the analysis of claims at alternative limits and within layers (e.g., 900,000 excess of 100,000 limits). In the first approach, the development method is used directly with reported claims data at alternative limits. Next, a theoretical approach is presented for estimating development using formulaic relationships between the development factors at different limits. Such an approach may be needed when complete data triangles at alternative limits are not available or when the available data are insufficient or unreliable.

The theoretical approach relies on formulas that were developed by Jerome J. Siewert in *A Model for Reserving Workers Compensation High Deductibles*. (Siewert, 1996) Siewert used the following notation:[19]

- *CDF* = cumulative development factor at total limits;
- *XSCDF* = cumulative development factor for excess claims;
- t = age (e.g., 12 months, 24 months);
- L = limit, which may represent basic limit, a deductible, SIR, or excess reinsurance limit;
- S = severity (at an ultimate value if no reference to t); and
- R^L = severity relativity, severity at limit L divided by unlimited severity.

Siewart's formulas reflect the relationships between full coverage claims development and severity relativities at different limits. Siewert indicates that the motivation for the relationships resulted from the desire to partition total claims development in a consistent manner between limited and excess development. Two of his formulas are summarized in Table I.1.

[19] Siewert's formulas are modified to be consistent with this textbook. For example, Siewert uses *LDF*, while this textbook uses *CDF*.

Table I.1

Siewart's Development Formulas[20]

$$(4.2)\quad CDF^L = CDF \cdot \frac{R^L}{R_t^L}$$

$$(4.3)\quad XSCDF^L = CDF \cdot \frac{(1-R^L)}{(1-R_t^L)}$$

I.2 DENTIST INSURER – PROFESSIONAL LIABILITY

I.2.1 PROJECTED ULTIMATE CLAIMS USING ACTUAL DEVELOPMENT DATA AT ALTERNATIVE LIMITS

The case study for Dentist Insurer is presented in Appendix A. Exhibit VI-1 summarizes the reported claims development triangles at total limits, which for purpose of this case study are assumed equal to unlimited claims. The development triangle for basic limit reported claims (without development analysis) is presented in Exhibit I-1 of Appendix A. The basic limit for Dentist Insurer is defined to be 200,000. The reported claims development triangle excess of 200,000 is calculated by subtracting the reported claims at 200,000 limits from the reported claims at total limits. Table I.2 summarizes the development triangles for 200,000 limits reported claims as well as the age-to-age factor analysis including selected factors and cumulative development factors. Table I.3 presents the reported claims triangle and age-to-age factor analysis for excess of 200,000 limits. The selected factors at 200,000 limits and excess of 200,000 limits are based on the volume weighted all years averages. The volume weighted all years averages are used solely for illustration purposes. In practice, the actuary would follow the process outlined in Chapter 14 and consider different types of averages and different experience periods.

[20] Formula numbers are from his paper so readers who elect to learn more by reading the paper can find them.

Table I.2

Dentist Insurer – Professional Liability
Reported Claims Development Analysis at 200,000 Limit

Report	Reported Claims at 200,000 Limit							
Year	12	24	36	48	60	72	84	96
RY1	6,216	9,279	9,611	9,612	9,831	9,862	9,863	9,863
RY2	7,557	12,593	12,471	12,773	12,894	12,956	12,944	
RY3	8,333	11,268	11,638	11,769	11,752	11,786		
RY4	7,858	11,582	11,816	11,982	12,067			
RY5	7,655	13,001	13,863	13,963				
RY6	8,044	13,062	13,258					
RY7	8,477	15,364						
RY8	8,299							

Report	Age-to-Age Factors							
Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
RY1	4.911	0.921	1.086	1.023	1.013	1.006	1.000	
RY2	26.578	1.460	0.973	0.949	1.004	1.007		
RY3	3.569	1.661	1.610	1.190	0.999			
RY4	3.275	1.117	1.090	1.101				
RY5	15.667	1.699	1.152					
RY6	1.895	1.675						
RY7	2.739							
Vol Wtd All	4.059	1.289	1.166	1.072	1.006	1.007	1.000	
Selected	4.059	1.289	1.166	1.072	1.006	1.007	1.000	1.000
CDF	6.625	1.632	1.266	1.086	1.013	1.007	1.000	1.000

Table I.3

Dentist Insurer – Professional Liability
Reported Claims Development Analysis Excess of 200,000 Limit

Report	Reported Claims Excess of 200,000 Limit							
Year	12	24	36	48	60	72	84	96
RY1	597	2,932	2,701	2,932	2,998	3,038	3,057	3,057
RY2	45	1,196	1,746	1,699	1,612	1,619	1,631	
RY3	267	953	1,583	2,548	3,032	3,029		
RY4	448	1,467	1,639	1,786	1,967			
RY5	54	846	1,437	1,656				
RY6	579	1,097	1,838					
RY7	314	860						
RY8	722							

Report	Age-to-Age Factors							
Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
RY1	4.911	0.921	1.086	1.023	1.013	1.006	1.000	
RY2	26.578	1.460	0.973	0.949	1.004	1.007		
RY3	3.569	1.661	1.610	1.190	0.999			
RY4	3.275	1.117	1.090	1.101				
RY5	15.667	1.699	1.152					
RY6	1.895	1.675						
RY7	2.739							
Vol Wtd All	4.059	1.289	1.166	1.072	1.006	1.007	1.000	
Selected	4.059	1.289	1.166	1.072	1.006	1.007	1.000	1.000
CDF	6.625	1.632	1.266	1.086	1.013	1.007	1.000	1.000

It is readily apparent how much lower the claim volume is and how much higher and more volatile the age-to-age factors are for reported claims excess 200,000 limits than at 200,000 limits. The volatility of the age-to-age factors at the four earliest age-to-age intervals is demonstrated by the differences in the maximum and minimum values (referred to as the range) and the standard deviations seen in Table I.4.

Table I.4

Dentist Insurer – Professional Liability
Volatility in Age-to-Age Factors

	200,000 Limits Age-to-Age Factors			
	12-24	24-36	36-48	48-60
Range	0.460	0.076	0.024	0.024
Std Dev	0.157	0.025	0.009	0.010

	xs 200,000 Limits Age-to-Age Factors			
	12-24	24-36	36-48	48-60
Range	24.683	0.777	0.637	0.241
Std Dev	9.304	0.330	0.248	0.104

Such volatility for the excess of 200,000 limits introduces significantly more uncertainty when using a projection method that relies on development factors. The age-to-age factors for the excess claims data are also greater and more volatile than the age-to-age factors at total limits, which are in Exhibit VI-1 of Appendix A.

The projections of ultimate claims using the development method and the calculation of indicated IBNR are presented for 200,000 limits and excess of 200,000 limits in Table I.5. Detailed column notes are included at the bottom of Table I.5.

Table I.5

Dentist Insurer – Professional Liability
Projection of Ultimate Claims and Indicated IBNR
Using Development Patterns Based on Actual Claims Data

	Reported Claims at 12/31/CY8		Estimated CDF		Projected Ultimate Claims		Indicated IBNR at 12/31/CY8	
Report Year	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RY1	9,863	3,057	1.000	1.000	9,863	3,057	0	0
RY2	12,944	1,631	1.000	1.000	12,944	1,631	0	0
RY3	11,786	3,029	1.000	1.007	11,786	3,050	0	21
RY4	12,067	1,967	1.004	1.013	12,115	1,993	48	26
RY5	13,963	1,656	1.013	1.086	14,145	1,798	182	142
RY6	13,258	1,838	1.025	1.266	13,589	2,327	331	489
RY7	15,364	860	1.052	1.632	16,163	1,404	799	544
RY8	8,299	722	1.673	6.625	13,884	4,783	5,585	4,061
Total	97,544	14,760			104,489	20,043	6,945	5,283

Column Notes:

(2) to (5) From Tables I.2 and I.3.

(6) = [(2) × (4)].

(7) = [(3) × (5)].

(8) = [(6) – (2)].

(9) = [(7) – (3)].

For a full analysis of ultimate values, multiple projection methods would be used at each limit. Similarly, diagnostics (such as frequencies, severities, and claim ratios) of the indicated results would also be reviewed.

Sufficient and reliable historical data are not always available. An insurer may face data constraints due to lack of systems capabilities to access data at varied limits. An insurer may be entering new lines of business, writing at new retentions or limits, or facing significant change in the terms and conditions of its contracts (e.g., treatment of ALAE) such that historical experience is not relevant. In these circumstances, an insurer could consider a theoretical approach for developing cumulative development factors, which may or may not be based on the insurer's own experience.

I.2.2 PROJECTED ULTIMATE CLAIMS USING THEORETICALLY-DERIVED DEVELOPMENT FACTORS AT ALTERNATIVE LIMITS

If data for Dentist Insurer were not available or were deemed to be insufficient or unreliable, then the actuary would need an alternative approach to derive cumulative development factors at 200,000 limits and excess of 200,000 limits. Siewert's formulas provide such an alternative.

To use Siewert's formulas, the first step is to determine unlimited cumulative development factors. For Dentist Insurer, the total limits (which are assumed to be equal to unlimited) cumulative development factors are presented in Appendix A, Exhibit VI-1. Table I.6 summarizes the total limits selected age-to-age and cumulative development factors for Dentist Insurer.

Table I.6

Dentist Insurer – Professional Liability
Total Limits Reported Claims – Selected Age-to-Age Factors and CDFs

	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
Selected	1.692	1.055	1.032	1.019	1.004	1.001	1.000	1.000
CDF	1.887	1.115	1.057	1.024	1.005	1.001	1.000	1.000

The next step for using Siewert's formulas, is to determine the severity relativities at each maturity age t (R_t). To determine R_t, the actuary must calculate limited and unlimited severities for each report year in the experience period at each maturity age. This is a complex task given the different trend rates that are associated with claims at differing limits. The actuary may use actual historical data for this exercise, industry data, or a combination. The relativities may be derived directly from observed experience or from statistical models or simulation analyses. Professional judgment will likely play an important role in the development of these relativities.

For this example, R_t are estimated based on a combination of the observed ratios of basic limit severities to total limits severities as well as key values selected for the ratemaking analysis in Appendix A including the selected trend rates for basic limit and total limits severities, the selected basic limit severity at a January 1, CY10 cost level, and the large claim loading. The R_t values are summarized in Table I.7.

Table I.7[21]

Dentist Insurer – Professional Liability
Summary of Severity Relativity (R) by Maturity Age

	12	24	36	48	60	72	84	96
R_t	0.901	0.833	0.814	0.807	0.800	0.797	0.796	0.796

Given cumulative development factors for unlimited reported claims and the severity relativities of 200,000 limits to total limits, development factors at 200,000 limits and development factors excess of 200,000 limits can be determined using Siewert's formulas

[21] The reader is not expected to be able to reproduce the R_t values in the examples in this appendix. They are presented for Dentist Insurer and Homeowners Insurer for purposes of illustration only.

(4.2) and (4.3), respectively, from Table I.1. Table I.8 summarizes these derived cumulative development factors.

Table I.8

Dentist Insurer – Professional Liability
Estimation of 200,000 Limits and Excess of 200,000 Limits Reported CDFs
Using Siewert's Formulas

	12	24	36	48	60	72	84	96
CDF Unlimited	1.887	1.115	1.057	1.024	1.005	1.001	1.000	1.000
R_t	0.901	0.833	0.814	0.807	0.800	0.797	0.796	0.796
CDF 200,000	1.667	1.065	1.034	1.010	1.000	1.000	1.000	1.000
CDF xs 200,000	3.888	1.362	1.159	1.082	1.025	1.006	1.000	1.000

To determine the cumulative development factor at 200,000 limits, Siewert's formula (4.2) is used. (Siewert, 1996) For example, the 12-month cumulative development factor at 200,000 limits of 1.667 is equal to the 12-month cumulative development factor at total limits of 1.887 multiplied by the ratio of the severity relativity at 96 months (0.796) divided by the severity relativity at 12 months (0.901).

$$1.667 = 1.887 \times (0.796 / 0.901).$$

Similar calculations are performed at each subsequent maturity age.

To determine the cumulative development factor excess of 200,000 limits, Siewert's formula (4.3) is used. For example, the 24-month cumulative development factor excess of 200,000 limits of 1.362 is equal to the 24-month cumulative development factor at total limits of 1.115 multiplied by the ratio of 1 minus the severity relativity at 96 months (0.796) divided by 1 minus the severity relativity at 24 months (0.833).

$$1.362 = 1.115 \times (1 - 0.796) / (1 - 0.833).$$

Similar calculations are performed at all maturity ages.

Table I.9 presents the projection of ultimate claims and indicated IBNR using these derived development patterns.

Table I.9

Dentist Insurer – Professional Liability
Projection of Ultimate Claims and Indicated IBNR using Theoretically-Derived Development Patterns

	Reported Claims at 12/31/CY8		Estimated CDF		Projected Ultimate Claims		Indicated IBNR at 12/31/CY8	
Report Year	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RY1	9,863	3,057	1.000	1.000	9,863	3,057	0	0
RY2	12,944	1,631	1.000	1.000	12,944	1,631	0	0
RY3	11,786	3,029	1.000	1.006	11,786	3,047	0	18
RY4	12,067	1,967	1.000	1.025	12,067	2,016	0	49
RY5	13,963	1,656	1.010	1.082	14,103	1,792	140	136
RY6	13,258	1,838	1.034	1.159	13,709	2,130	451	292
RY7	15,364	860	1.065	1.362	16,363	1,171	999	311
RY8	8,299	722	1.667	3.888	13,834	2,807	5,535	2,085
Total	97,544	14,760			104,669	17,651	7,125	2,891

Column Notes:

(2) and (3) From Tables I.2 and I.3.

(4) and (5) From Table I.8.

(6) = [(2) × (4)].

(7) = [(3) × (5)].

(8) = [(6) – (2)].

(9) = [(7) – (3)].

Table I.10 presents a comparison of the results of the development method using actual data as the basis for deriving development patterns and the theoretically derived patterns. Indicated IBNR is compared at 200,000 limits and excess of 200,000 limits.

Table I.10

Dentist Insurer – Professional Liability
Comparison of Indicated IBNR at December 31, CY8

	Indicated IBNR at 12/31/CY8				Difference in	
	Using Actual Data		Theoretical Patterns		Indicated IBNR	
Report Year	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits	200,000 Limits	xs 200,000 Limits
(1)	(2)	(3)	(4)	(5)	(6)	(7)
RY1	0	0	0	0	0	0
RY2	0	0	0	0	0	0
RY3	0	21	0	18	0	3
RY4	48	26	0	49	48	–23
RY5	182	142	140	136	42	6
RY6	331	489	451	292	–120	197
RY7	799	544	999	311	–200	233
RY8	5,585	4,061	5,535	2,085	50	1,976
Total	6,945	5,283	7,125	2,891	–180	2,392

Column Notes:

(2) and (3) From Table I.5.

(4) and (5) From Table I.9.

(6) = [(2) – (4)].

(7) = [(3) – (5)].

While the difference in indicated IBNR is not significant at 200,000 limits, there is a notable difference excess of 200,000 limits. The cumulative development factors at 12 and 24 months are greater using actual data than those derived by a theoretical approach. Given the volatility seen in the age-to-age factors at the earliest maturity ages as well as the limited volume, which is likely related to the volatility, the actuary should consider alternative sources and/or methods for RY7 and RY8.

I.2.3 PROJECTED ULTIMATE CLAIMS USING THE EXPECTED METHOD

As noted in Chapter 16, the expected method is frequently used for immature experience periods. This is true for insurers, reinsurers, and self-insurers. It is important to note that the actuary's assessment of the maturity of a particular report (or accident) year could vary based on the limit of claims experience under review. For example, at 200,000 limits, the cumulative development factor to ultimate for RY8 is 1.673 based on actual data or 1.667 using a theoretical approach, both of which indicate roughly 60% of RY8 claims are reported. In contrast, the cumulative development factors for RY8 for excess of 200,000 limits indicate roughly 15% to 26% reported, which would be considered far less mature for the same report year.

Given the immature nature of RY8, particularly excess of 200,000 limits, the expected method would be a viable alternative for the actuary. The actuary may use earned premiums multiplied by an expected claims ratio, which could be based on the insurer's historical experience or industry data adjusted to reflect the insurer's circumstances.

I.2.4 PROJECTED ULTIMATE CLAIMS USING INCREASED LIMITS FACTORS

Alternatively, the actuary could use an increased limits factors applied to projected ultimate limited claims. Chapter 33 is focused on limits and deductible factors for ratemaking. Many of the concepts are equally applicable for actuaries estimating ultimate claims for financial reporting purposes. In the case study for Dentist Insurer, a large claims loading of 1.285 is selected for ratemaking purposes. Recall that the large claims loading is based on an analysis of the ratios of total limits claims to basic limits claims developed and trended to January 1, CY10. To determine the limits factor to use for projecting ultimate claims for RY8, the selected limits factor at January 1, CY10 must be adjusted for trend to a July 1, CY8 cost level. Consistent with the approach in Appendix A, Exhibit XII-7, the increased limits factor at 200,000 limit for RY8 is estimated to be 1.257 ($1.285 \times 1.015^{-1.5}$). A projection of total limits claims for RY8 can be calculated as:

Projected ultimate claims at 200,000 limit × selected loading for large claims =

$$13{,}884 \times 1.257 = 17{,}452.$$

Using this projection of total limits claims, a projection for excess of 200,000 limits can be derived by subtraction as:

Projected ultimate claims at total limits – projected ultimate claims at 200,000 limits =

$$17{,}452 - 13{,}884 = 3{,}568.$$

For Dentist Insurer, the expected estimate of claims excess of 200,000 limits of 3,568 happens to be between the two estimates from the development method of 4,061 (based on actual data) and 2,085 (based on theoretical development patterns). It is important to recognize that this will not always be the situation.

I.3 HOMEOWNERS INSURER – PROPERTY

I.3.1 PROJECTED ULTIMATE CLAIMS USING ACTUAL DEVELOPMENT DATA AT ALTERNATIVE LIMITS

The next example is based on the case study for Homeowners Insurers presented in Appendix C and uses the data for property excluding weather and all catastrophe claims. In practice, one would not exclude weather and catastrophe claims. The data are used here as is for the purpose of exemplifying key concepts and considerations in the development patterns at alternative limits (100,000 and 1 million) and within a layer (900,000 excess of 100,000 limits).

In this case study, reported claims data are available at three limits: 100,000; 1 million; and total limits. The analysis follows similar logic and presentation as Dentist Insurer. The

reported claims data, age-to-age factors, and selected factors (including cumulative development factors) are presented in Appendix C:

- Exhibit X-1 at total limits (which is assumed equivalent to unlimited);
- Exhibit X-3 at 100,000 limits; and
- Exhibit X-5 at 1 million limits.

Tables I.11 and I.12 present reported claims and development factors in the layer 900,000 excess of 100,000 and excess of 1 million, respectively.

Table I.11

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Reported Claims Development Analysis for 900,000 Excess 100,000 Limits

Accident	Reported Claims for 900,000 Excess 100,000 Limits							
Year	12	24	36	48	60	72	84	96
AY23	896	939	963	973	989	992	992	992
AY24	840	860	877	883	886	889	889	
AY25	997	1,119	1,136	1,143	1,149	1,152		
AY26	1,441	1,595	1,617	1,625	1,632			
AY27	1,281	1,275	1,281	1,296				
AY28	1,294	1,382	1,404					
AY29	1,433	1,599						
AY30	1,680							

Accident	Age-to-Age Factors							
Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
AY23	1.048	1.026	1.010	1.016	1.003	1.000	1.000	
AY24	1.024	1.020	1.007	1.003	1.003	1.000		
AY25	1.122	1.015	1.006	1.005	1.003			
AY26	1.107	1.014	1.005	1.004				
AY27	0.995	1.005	1.012					
AY28	1.068	1.016						
AY29	1.116							
Vol Wtd All	1.072	1.015	1.008	1.007	1.003	1.000	1.000	
Selected	1.072	1.015	1.008	1.007	1.003	1.000	1.000	1.000
CDF	1.108	1.033	1.018	1.010	1.003	1.000	1.000	1.000

Table I.12

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Reported Claims Development Analysis for Excess 1 Million Limits

Accident	Reported Claims Excess 1 Million Limits							
Year	12	24	36	48	60	72	84	96
AY23	-	-	-	-	-	-	-	-
AY24	158	277	276	278	285	285	285	
AY25	-	-	-	-	-	-		
AY26	-	-	-	-	-			
AY27	298	329	341	343				
AY28	41	47	48					
AY29	-	5						
AY30	5							

Accident	Age-to-Age Factors							
Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
AY23								
AY24	1.753	0.996	1.007	1.025	1.000	1.000		
AY25								
AY26								
AY27	1.104	1.036	1.006					
AY28	1.146	1.021						
AY29								
Vol Wtd All	1.324	1.018	1.006	1.025	1.000	1.000		
Selected	1.324	1.018	1.006	1.025	1.000	1.000	1.000	1.000
CDF	1.390	1.050	1.031	1.025	1.000	1.000	1.000	1.000

The scarcity of data and the volatility in age-to-age factors for excess of 1 million limits are problematic for an actuary seeking an estimate of ultimate claims for this limit. The actuary would need to turn to alternative methods and/or data sources as the data presented in Table I.12 are too scarce for reliable projections. The actuary could potentially turn to similar lines of business within the organization, industry data, or professional judgment. Documenting the source of data and the rationale for its use is critically important. For purposes of this example, the development factors for excess of 1 million are derived from the volume weighted averages of the data available. In reality, this insurer's data alone would not be deemed sufficient.

Table I.13 summarizes projected ultimate claims and indicated IBNR based on the reported claims development method for the layer 900,000 excess of 100,000, and the excess of 1 million layer.

Table I.13

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Projection of Ultimate Claims and Indicated IBNR
Using Development Patterns Based on Actual Claims Data

	Reported Claims at 12/31/CY30		Estimated CDF		Projected Ultimate Claims		Indicated IBNR at 12/31/CY30	
Accident Year	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AY23	992	-	1.000	1.000	992	-	0	0
AY24	889	285	1.000	1.000	889	285	0	0
AY25	1,152	-	1.000	1.000	1,152	-	0	0
AY26	1,632	-	1.003	1.000	1,637	-	5	0
AY27	1,296	343	1.010	1.025	1,309	352	13	9
AY28	1,404	48	1.018	1.031	1,429	49	25	1
AY29	1,599	5	1.033	1.050	1,652	5	53	0
AY30	1,680	5	1.108	1.390	1,861	7	181	2
Total	10,644	686			10,921	698	277	12

Column Notes:

(2) to (5) From Tables I.11 and I.12.

(6) = [(2) × (4)].

(7) = [(3) × (5)].

(8) = [(6) – (2)].

(9) = [(7) – (3)].

None of the cumulative development factors would be considered highly leveraged. This is not surprising for property, which is a short-tail line of business, and is also not surprising for the layer 900,000 excess of 100,000, which is typically considered a relatively low attachment point and layer. As noted previously, the data excess of 1 million are not considered reliable given the sparsity of claims.

I.3.2 PROJECTED ULTIMATE CLAIMS USING THEORETICALLY-DERIVED DEVELOPMENT FACTORS AT ALTERNATIVE LIMITS

In this section, Siewert's formulas are used to derive projections of ultimate claims and estimates of IBNR for the layer 900,000 excess of 100,000 limits and excess of 1 million limits. Similar to Dentist Insurer, the first step is the development of unlimited cumulative development factors, which are assumed equal to total limits cumulative development factors; these factors are presented in Exhibit X-1 in Appendix C and summarized in Table I.14.

Table I.14

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Total Limits Reported Claims – Selected Age-to-Age Factors and CDFs

	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-Ult
Selected	1.073	1.008	1.006	1.004	1.001	1.000	1.000	1.000
CDF	1.094	1.019	1.011	1.005	1.001	1.000	1.000	1.000

The next step is to determine the severity relativities at each maturity age t (R_t). The expected severities at alternative limits and at successive maturity ages can be determined based on observed experience of the insurer, industry experience, modeling techniques, or professional judgment. Once again, the documentation of assumptions and approach is a very important part of actuarial work.

For Homeowners Insurer, the data and analyses presented in Appendix C are used to derive expected severity relativities for 100,000 limits to unlimited and for 1 million limits to unlimited. These relativities at successive age intervals are presented in Table I.15.

Table I.15

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Summary of Severity Relativities (R_t) by Maturity Age

	12	24	36	48	60	72	84	96
R_t 100,000 to Unltd	0.646	0.626	0.624	0.623	0.622	0.620	0.620	0.620
R_t 1 Million to Unltd	0.982	0.977	0.973	0.972	0.971	0.970	0.970	0.970

Given cumulative development factors for unlimited reported claims and the severity relativities of 100,000 limits to unlimited and 1 million to unlimited, cumulative development factors at 100,000 limits and excess of 1 million limits can be determined using Siewert's formulas. These factors are presented by maturity age in Table I.16.

Table I.16

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims
Estimation of Reported CDFs at Alternative Limits
Using Siewert's Formulas

	12	24	36	48	60	72	84	96
CDF Unlimited	1.094	1.019	1.011	1.005	1.001	1.000	1.000	1.000
CDF 100,000	1.050	1.009	1.005	1.000	0.998	1.000	1.000	1.000
CDF 1 Million	1.081	1.012	1.008	1.003	1.000	1.000	1.000	1.000
CDF xs 1 Million	1.823	1.329	1.123	1.077	1.036	1.000	1.000	1.000

To determine the cumulative development factor at 100,000 limits and 1 million limits, Siewert's formula (4.2) is used. For example, the 12-month cumulative development factor at 100,000 limits of 1.050 is equal to the 12-month cumulative development factor at total limits of 1.094 multiplied by the ratio of the severity relativity at 96 months (0.620) divided by the severity relativity at 12 months (0.646).

$$1.050 = 1.094 \times (0.620 / 0.646).$$

Similar calculations are performed at each subsequent maturity age for 100,000 limits and 1 million limits.

To determine the cumulative development factor excess of 1 million limits, Siewert's formula (4.3) is used. For example, the 36-month cumulative development factor excess of 1 million limits of 1.123 is equal to the 36-month cumulative development factor at total limits of 1.011 multiplied by the ratio of 1 minus the severity relativity at 96 months (0.970) divided by 1 minus the severity relativity at 36 months (0.973).

$$1.123 = 1.011 \times (1 – 0.970) / (1 – 0.973).$$

Similar calculations are performed at all maturity ages for excess of 1 million limits.

Table I.17 presents the projection of ultimate claims and indicated IBNR using these derived development patterns at alternative limits and the layer 900,000 excess 100,000 limits. The projected ultimate claims for the layer 900,000 excess 100,000 limits are equal to the development projections at 1 million limits minus the development projections at 100,000 limits. Detailed notes for each column are included at the bottom of the table.

Table I.17

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims Projection of Ultimate Claims and Indicated IBNR Using Theoretically-Derived Development Patterns

Accident Year	Reported Claims at 12/31/CY30			Estimated CDF		
	100,000	1 Million	xs 1 Million	100,000	1 Million	xs 1 Million
(1)	(2)	(3)	(4)	(5)	(6)	(7)
AY23	2,541	3,533	-	1.000	1.000	1.000
AY24	1,764	2,653	285	1.000	1.000	1.000
AY25	1,891	3,043	-	1.000	1.000	1.000
AY26	2,696	4,328	-	0.998	1.000	1.036
AY27	2,816	4,112	343	1.000	1.003	1.077
AY28	2,492	3,896	48	1.005	1.008	1.123
AY29	3,185	4,784	5	1.009	1.012	1.329
AY30	3,198	4,878	5	1.050	1.081	1.823
Total	20,583	31,227	686			

Accident Year	Projected Ultimate Claims				Indicated IBNR at 12/31/CY30	
	100,000	1 Million	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million
(1)	(8)	(9)	(10)	(11)	(12)	(13)
AY23	2,541	3,533	992	-	0	0
AY24	1,764	2,653	889	285	0	0
AY25	1,891	3,043	1,152	-	0	0
AY26	2,691	4,328	1,637	-	5	0
AY27	2,816	4,124	1,308	369	12	26
AY28	2,504	3,927	1,423	54	19	6
AY29	3,214	4,841	1,627	7	28	2
AY30	3,358	5,273	1,915	9	235	4
Total	20,779	31,722	10,943	724	299	38

Column Notes:

(2) and (3) From Appendix C, Exhibits X-3 and X-5.

(4) From Table I.12.

(5) to (7) From Table I.16.

(8) = [(2) × (5)].

(9) = [(3) × (6)].

(10) = [(9) – (8)].

(11) = [(4) × (7)].

(12) = [(10) – ((3) – (2))].

(13) = [(11) – (4)].

Table I.18 presents a comparison of the results of the development method using actual data as the basis for deriving development patterns and the theoretically derived patterns. Indicated IBNR is compared for the layer 900,000 excess of 100,000 limits and excess of 1 million limits.

Table I.18

Homeowners Insurer – Property excluding Weather and all Catastrophe Claims Projection of Ultimate
Comparison of Indicated IBNR at December 31, CY30

	Indicated IBNR at 12/31/CY30				Difference in Indicated IBNR	
	Using Actual Data		Theoretical Patterns			
Accident Year	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million	900,000 xs 100,000	xs 1 Million
(1)	(2)	(3)	(4)	(5)	(6)	(7)
AY23	0	0	0	0	0	0
AY24	0	0	0	0	0	0
AY25	0	0	0	0	0	0
AY26	5	0	5	0	0	0
AY27	13	9	12	26	1	–17
AY28	25	1	19	6	6	–5
AY29	53	0	28	2	25	–2
AY30	181	2	235	4	–54	–2
Total	277	12	299	38	–22	–26

Column Notes:

(2) and (3) From Table I.13.

(4) and (5) From Table I.17.

(6) = [(2) – (4)].

(7) = [(3) – (5)].

The difference in projections is far less for Homeowners Insurer than observed for Dentist Insurer, which is not surprising given the much shorter-tail nature of property versus professional liability insurance. The only cumulative development factor that would be considered highly leveraged is the excess of 1 million at 12 months maturity; all other cumulative development factors are less than 1.1, which indicates more than 90% of claims are reported. For excess of 1 million limits, the actuary should seek an alternative method, such as an expected method. As noted for Dentist Insurer, this appendix focuses on development patterns at alternative limits and does not present multiple methods for estimating ultimate claims. An actuary who is required to project ultimate claims at such limits should consider more than one method.

I.4 THE NEED FOR PROFESSIONAL JUDGMENT

When using Siewert's formulas, the actuary will need to exercise professional judgment as the estimated relativities at alternative limits can result in unusual cumulative development factors. There can be unexpected reversals where cumulative development factors are higher at older maturity ages and there can be cumulative development factors that are higher for limited values than excess or unlimited. The formulas are very sensitive to the R_t values and the change in these values across the maturity ages. In the examples in this appendix, the R_t values are deliberately selected to avoid such issues.

Another area for professional judgment is in the use of increased limits factors. It is imperative to review the material on increased limits factors in Chapter 33 in detail. Whether using the insurer's own experience or industry data, there are many issues to consider when applying increased limits factors. This is particularly important for reinsurers and self-insurers (whether due to large deductible programs, SIRs, or other programs). The influence of trend and different treatment of ALAE exemplify two issues that should be considered when deriving a limits factor. When using industry limits factors, it is particularly important for the actuary to understand if the factors are applicable to claims or to premiums. If limits factors are stated relative to premium, then the actuary would need to adjust the factors by an expected claims ratio prior to use with claims.

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