Educational Note

Considerations for Trending Procedures in Property and Casualty Insurance Pricing

Committee on Property and Casualty Insurance Pricing

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The actuary should be familiar with relevant educational notes. They do not constitute standards of practice and are, therefore, not binding. They are, however, intended to illustrate the application of the Standards of Practice, so there should be no conflict between them. The actuary should note however that a practice that the educational notes describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation. Responsibility for the manner of application of standards of practice in specific circumstances remains that of the members. As standards of practice evolve, an educational note may not reference the most current version of the Standards of Practice; and as such, the actuary should cross-reference with current Standards. To assist the actuary, the CIA website contains an up-to-date reference document of impending changes to update educational notes.

MEMORANDUM

To: Members in the property and casualty insurance area

From: Steven W. Easson, Chair
Actuarial Guidance Council

Adam Scarth, Chair
Committee on Property and Casualty Insurance Pricing

Date: April 1, 2022

Subject: **Educational Note: Considerations for Trending Procedures in Property and Casualty Insurance Pricing**

The Committee on Property and Casualty Insurance Pricing (CPCIP) has prepared this educational note to provide guidance on various actuarial considerations related to trending procedures in P&C insurance pricing.

This educational note is structured in sections as follows:

- Sections 1 through 4 provide an overview of the purpose and scope of the educational note, in addition to definitions of terminology used.
- Section 5 presents considerations related to the purpose and use of trending procedures.
- Section 6 describes how the actuary would consider the influence of economic and social inflation when selecting trends.
- Sections 7 through 9 describe considerations related to data used for trending procedures.
- Section 10 gives guidance around the time periods for trending procedures.
- Section 11 provides guidance related to data adjustments that may be considered when selecting trends.
- Section 12 describes some of the considerations for selecting trends based on a separate analysis of frequency and severity.
- Section 13 defines outliers in data and lists some options for treatment.
- Section 14 summarizes considerations for the actuary when selecting trends.
- Sections 15 and 16 describe considerations for the actuary related to model validation, peer review, and documentation.

A preliminary version of the educational note was shared with members of the CPCIP, the Committee on Property and Casualty Insurance Financial Reporting (PCFRC), and the Committee on the Appointed/Valuation Actuary (A/VAC) for their review and comments, and presented to the Actuarial Guidance Council (AGC) for approval to distribute.

The CPCIP is satisfied it has sufficiently addressed the material comments received by the CPCIP members, the PCFRC, the A/VAC, and the AGC.

The creation of this cover letter and educational note has followed the AGC protocol for the adoption of educational notes. In accordance with the CIA's *Policy on Due Process for the Approval of Guidance Material other than Standards of Practice and Research Documents*, this educational note has been prepared by the CPCIP and has received approval for distribution from the AGC on March 8, 2022.

The actuary should be familiar with relevant educational notes. They do not constitute Standards of Practice and are, therefore, not binding. They are, however, intended to illustrate the application of the Standards of Practice, so there should be no conflict between them. The actuary should note however that a practice that the educational notes describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation. Responsibility for the manner of application of standards of practice in specific circumstances remains that of the members. As Standards of Practice evolve, an educational note may not reference the most current version of the Standards of Practice; and as such, the actuary should cross-reference with current Standards. To assist the actuary, the CIA website contains an up-to-date reference document of impending changes to update educational notes.

We would like to thank members of the CPCIP who drafted this guidance: Dane Grand-Maison, Rajesh Sahasrabuddhe, Philippe Farrier, Christopher So, Cong Wang, Shayan Sen, and a special thank you to Jacqueline Friedland of the CIA for assisting in development of this educational note.

Questions or comments regarding this educational note may be directed to the Chair of CPCIP and this Subcommittee at guidance.feedback@cia-ica.ca.

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1. Purpose

This educational note provides guidance to the actuary when performing professional services,[1] specifically trending procedures, to estimate future values for pricing of property and casualty (P&C) risk.

2. Scope

This educational note applies to the actuary when performing professional services to estimate future values using trending procedures for pricing of all P&C coverages. This includes work performed for insurance or reinsurance companies and other P&C risk financing systems that provide similar coverage, such as self-insurance.

For clarity, a trending procedure does not encompass the process commonly referred to as "loss development," which estimates changes over time in losses (or other items such as claim counts, loss adjustment expenses) within a given exposure period. A trending procedure also does not include premium development, or "premium on-leveling" which adjusts data for changes in exposure levels. Trending procedures would be applied to data that is at a consistent maturity and adjusted for exposure changes.

Common trends in P&C ratemaking include premium, exposure, and loss trends. Because consideration of loss trends is central to most P&C insurance ratemaking and can be material to the results, this guidance is presented in the context of loss trends. Other trends will therefore not be explicitly addressed in this educational note, although the guidance herein may still be relevant.

While this educational note is targeted at the actuary conducting pricing work, the educational guidance contained herein would also have value to the actuary using trending procedures for reserving, financial condition testing, marketing, underwriting, and other uses.

3. Definitions

For purposes of this educational note, defined terms are listed below:

Coverage: The terms and conditions of a plan or contract, or the requirements of applicable law, that create an obligation for claim payment associated with contingent events.

Economic inflation: Changes in the price of the underlying goods and services covered by insurance, such as wage, price inflation, and changes in currency exchange rates.

Experience period: The period of time to which historical data used for actuarial analysis pertain. The experience period typically includes data aggregated into exposure periods, which are subsets of the experience period.

Exposure period: The period used to aggregate data within the experience period (e.g., accident quarter, semi-annual report period, and policy year).

Forecast Period: The future time period to which the historical data are projected.

[1] "Professional services" are defined in the *Rules of Professional Conduct* as: "The rendering of advice, recommendations or opinions based upon actuarial considerations, including other services provided from time to time by a member to a client or employer." Accessed April 17, 2021.

Social inflation: The impact on insurance costs of societal changes, such as changes in claim consciousness, court practices, and legal precedents, as well as in other noneconomic factors.

Trend: As defined in subsection 1120 of the *Standards of Practice*, "trend is the tendency of data values to change in a general direction from one coverage period to a later coverage period."

Trending period: The time over which trend is applied in projecting from the experience period to the forecast period.

Trending procedure: Trending procedures refer to the assumptions, calculations, methodologies, and models used to derive estimates of trend.

4. Introduction

Trend is a critical assumption in the actuary's pricing analysis and can have a material influence on the determination of indicated rates. With trending procedures, the actuary uses mathematical techniques to smooth historical data and extrapolate into the forecast period. Procedures based on non-insurance data (e.g., price indices, economic data) are also used.

The actuarial *Standards of Practice* state in subsection 1140 Judgment: "There is a reasonable range of assumptions that may be selected by an actuary for particular work and that might produce materially different results."[2] In trending procedures, judgmental considerations generally include, but are not limited to, the historical data used, the success of techniques used in making prior projections, the statistical goodness of fit of the techniques to the historical data, and the effect of any sudden, nonrecurring changes (e.g., product reform) that are not incorporated in the historical data.

This educational note focuses on general actuarial considerations related to trending procedures and not the trending procedures themselves. Furthermore, it is not the intent of this educational note to identify, describe, or discuss methodologies or models used for specific trending procedures. For discussion on such topics, the actuary is referred to educational publications of the Casualty Actuarial Society, Actuarial Studies in Non-Life Insurance, and other publications (including statistics and economics textbooks) that provide extensive information on alternative trending procedures. Any discussion of methodology contained in this educational note is for the sole purpose of example and is not intended as an endorsement of a preferred methodology or approach.

The subsequent sections of this educational note address the following topics:

- purpose or use of trending procedures
- economic and social inflation
- sources of data
- types and aggregation of data
- requirement for sufficient and reliable data

[2] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraph 1140.05, accessed April 18, 2021.

- time periods for trending procedures
- data adjustments
- frequency and severity analyses
- outliers
- selection of trending procedures
- model validation
- documenting and reporting

5. Purpose or use of trending procedures

The actuary would identify the intended purpose or use of the trending procedure. The actuary would apply trending procedures that are appropriate for the applicable purpose or use.

Where multiple purposes or uses are intended, the actuary would consider the potential conflicts and consider adjustments if appropriate. For example, the actuary working in pricing at a large insurer may conduct trending procedures for a specific coverage and region and share their findings with another pricing actuary working on a different coverage and different region, as well as an actuary working in reserving and financial condition testing. In this situation, the actuaries receiving the trend selections would consider, given the different purposes of their work, whether the trends were appropriate or require adjustment for their own purposes.

The actuary may present the trend estimate resulting from the trending procedure in a variety of ways, such as a point estimate, a range of estimates, or a probability distribution of the trend estimate. When deciding how to present the trend estimate, the actuary would consider its intended purpose or use.

6. Economic and social inflation

In conducting trending procedures, the actuary would consider the influence of both economic and social inflation. The actuary's consideration of economic and social inflation may influence decisions related to the selection of the data to review, the length of the experience period, and the trending procedures. In addition, the actuary would consider the timing of the various influences.

7. Sources of data

In trending procedures, the actuary generally places reliance on data generated by the book of business being analyzed, other insurance data (e.g., industry data, data from another book of business), and non-insurance data. In choosing data sources, the actuary would consider the availability, relevance, and credibility (which incorporates considerations of the homogeneity, consistency, accuracy, and volume) of data. Potential sources of data include:

- internal company systems;
- advisory organizations (e.g., Insurers' Advisory Organization (IAO), Catastrophe Indices and Quantification Inc (CatIQ), and Insurance Bureau of Canada);

- industry statistical agencies (e.g., General Insurance Statistical Agency); and
- government (e.g., Statistics Canada and provincial statistical organizations such as the Office of Statistics and Information Alberta).

Subsection 1440[3] Data of the *Standards of Practice* addresses the requirements of the actuary related to data.

To evaluate the quality of a data source, the actuary would compare the data with other sources, consider its long-term consistency, and review any adjustments, omissions, or alterations to the data made by the provider of data. In seeking to understand the relevance of the data for trending procedures, examples of the actuary's considerations include:

- the value of industry data compared to the company's data or a subset of the company's data;
- the relevance of data from different jurisdictions (e.g., provinces or combination of provinces in a region);
- the applicability of varied classes of business (e.g., private passenger automobiles, motorcycles, and snowmobiles); and
- the appropriateness of combining data from different sources (e.g., company data with an affiliated company's data or with industry data).

8. Types and aggregation of data

Actuaries use many different types of data for trending procedures. For example, actuaries use:

- transactional claim data including claim counts and loss dollars;
- loss adjustment expense (LAE) including allocated loss adjustment expenses (ALAE) and unallocated loss adjustment expenses (ULAE);
- exposures, such as earned vehicles for automobile insurance, total insured values or earned buildings for property insurance, and earned premiums
- price and wage indices; and
- qualitative information, e.g., information gathered from agents, underwriters, claims staff or other sources.

Loss, count, and exposure data may be from internal sources of the company or external sources, such as an advisory organization or statistical agency. The actuary may also consider using data of related companies, such as a subsidiary, affiliated, or parent company.

When considering price indices, it is important for the actuary to isolate the categories of expense that are representative of the cost of claims for the coverage and region under review. For example, there are different building construction price indexes for residential buildings and non-residential buildings, and each of these are reported for different metropolitan areas

[3] https://www.cia-ica.ca/publications/publication-details/sc120120, subsection 1440, accessed April 18, 2021.

across Canada. Statistics Canada also reports on industrial product price indexes including separate statistics for lumber and for fabricated metal products and construction materials.

Data aggregation refers to how data are organized into exposure periods. Accident period is the most common approach for organizing P&C insurance loss (including ALAE) and claim count data. In certain situations, the use of policy, underwriting, or report period may be more suitable than accident period. For example, reinsurers frequently aggregate data by underwriting year; and report year is typically used for claims-made coverages (such as professional liability and errors and omissions liability). Calendar period aggregation is typically used for exposures, including earned premium and exposure units.

Within the various approaches to aggregation, data can be captured by different time intervals including month, quarter, semi-annual, and annual periods. Semi-annual and annual are common intervals for trending procedures. Actuaries working with large companies with extensive data may rely on quarterly data for trending procedures. An important consideration when relying on non-annual data is the potential effect of seasonality, which is addressed separately in this educational note. The actuary may use moving averages across successive time intervals to smooth experience but using these types of averages will also be less responsive to recent changes.

9. Requirement for sufficient and reliable data

The actuarial *Standards of Practice* require data that are sufficient and reliable, regardless of the source or type of data. Subsection 1440 Data states: "The actuary should apply such procedures as are necessary for the actuary to arrive at a conclusion as to the sufficiency and reliability of the data."[4] The *Standards of Practice* further state that data are sufficient if they include the needed information for the work, and data are reliable if they are sufficiently complete, consistent, and accurate for the purposes of the work.[5]

As with most actuarial work, the actuary conducting trending procedures would typically subdivide data into groups of claims that exhibit similar characteristics. Data that are homogenous exhibit similar patterns with respect to the:

- reporting and settlement of claims;
- frequency of claims (i.e., the number of claims relative to the number of exposures);
- severity of claims (i.e., the average value per claim);
- propensity for large claims;
- relationships between indemnity and expense; and
- relationships between indemnity and salvage and subrogation.

Examples of how the actuary may subdivide data include by major line of business, coverage within line of business, and geography.

[4] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraph 1440.01, accessed April 18, 2021.
[5] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraphs 1440.04 and 14404.05, accessed April 17, 2021.

The actuary would seek a balance between the homogeneity and volume of data. To achieve statistical reliability, or credibility, the actuary requires a sufficient volume of homogeneous data. A higher level of credibility is typically, although not always, achieved by increasing the volume of data. Simply increasing the volume of data does not increase credibility if the data are not relevant in terms of the characteristics noted in the previous list or in terms of the internal and external environment that the data represent. For example, the credibility will not increase if the larger data set includes experience influenced by changes in internal operations of the insurer or changes due to regulatory or legislative reforms in the coverage over the experience period.

Typically, the actuary first considers the data arising from the book of business to be the subject of the trending procedures. The actuary would consider whether such data are sufficient and reliable for discerning an underlying trend. For example, the actuary typically conducts trending procedures for automobile pricing by province. The data for a particular province, however, may not have sufficient credibility to support trending procedures, and the actuary may consider using supplemental data from other similar provinces or from industry data for the specific province under review.

When the actuary uses other data as a proxy for the book of business under review, the actuary would consider the relevance of the supplemental data to the original book. For example, when industry data are used, the actuary would consider if the mix of business is reasonably similar between the original book and the supplemental industry data. Continuing this example, the mix of business includes considerations such as the split of rural vs. non-rural exposures, standard vs. non-standard, and affinity groups vs. non-affinity, and other demographic characteristics to the extent such information is available.

Similarly, if the actuary were to use data from other provinces, the actuary would consider the similarity and relevance of data between the provinces. Differences in the product (such as types of coverage, thresholds, deductibles, and policy limits), weather patterns, and judicial environment typically lead to notable differences in loss experience and related trends.

The actuary may perform multiple trending procedures using more than one data set (e.g., internal company data, industry data, and a combination of company and industry data). The selection of a trend assumption based on a range of outputs from different trending procedures entails balancing the need for sufficient and reliable data, which includes the relevance of varied data sets. For example: when selecting the estimate of future trend, the actuary would consider the importance of a recent change in coverage provisions whose impact is estimated as part of the trending procedures.

10. Time periods for trending procedures

There are numerous time periods to consider in trending procedures. The experience period refers to the period of time from which historical data are used for the trending procedure. The forecast period is the future time period to which the historical data are projected.

For example, for trending procedures to support a pricing analysis, assume the actuary selects:

- semi-annual accident periods for the exposure period;

- an eight-semester experience period from July 1, 2016 to December 31, 2016 through January 1, 2020–June 30, 2020; and
- a forecast period of the January 1, 2021–December 31, 2021 policy year.

The actuary would consider both the lengths of the experience and forecast periods and relevant changes between the experience and forecast periods when determining the trending period. Selection of the experience period requires professional judgment. In selecting the experience period, the actuary would consider the available data, regulatory requirements, changes in operations, and changes to the external environment between the experience period and the forecast period.

When incorporating non-insurance data in the trending procedures, the actuary would consider the timing relationships among historical insurance data, the non-insurance data, and the future values being estimated.

There are advantages and disadvantages associated with the choice of both short and long experience periods. Two frequently cited advantages of a long experience period are the greater volume of data and thus the potential for increased credibility of the data. However, the relevance of data, or lack thereof, can be a concern with long experience periods. The actuary may question the applicability of data from older exposure periods to the forecast period, especially when estimating future trends for pricing purposes.

For example, when evaluating trends in the severity of property coverage, cost levels from four or five years in the past may not be relevant for estimating current or future costs due to different construction materials and practices related to technological advances.

Another issue with using a long experience period may be changes to the product over time that result in historical data that are not representative of future claims experience. For example, Canadian provinces have instituted, at times, significant changes in the private passenger automobile insurance product. Such changes can lead to material shifts in claims experience (both frequency and severity) and in the trends underlying such claims.

There can also be challenges in using a short experience period. For example, with a short experience period, the actuary may experience wider swings in the indicated trend between successive analyses. In a short experience period, outliers (i.e., unusual values) also have the potential to distort the trending procedures.

Similarly, major court decisions can result in changes in coverage, which can also influence loss trends. For example, in September 2016, the Supreme Court of Canada issued a decision on Ledcor Construction Limited vs. Northbridge Indemnity Insurance Company that addressed the issues of interpretation and application of the standard “faulty workmanship” exclusion in commercial all risks insurance policies. This court decision expanded the scope of coverage, which some insurers subsequently responded to with changes in the coverage wording or changes in price. The actuary conducting trending procedures would be aware of significant changes emanating from court decisions and reflect such in the choice of experience period and the methodology or model used for trending procedures.

For long-tail coverages (such as automobile liability and general liability), the actuary faces a challenge with the immaturity of data for the most recent exposure period. This may dictate the use of a long experience period, and the actuary would consider the relevance of data from older exposure periods.

Valuable insight can be gained from consideration of both short and long experience periods. Thus, the actuary would often consider a range of experience periods for trending procedures, documenting and communicating the strengths and weaknesses of the various indications with users of the work.

11. Data adjustments

The actuary would consider numerous adjustments prior to conducting trending procedures, such as:

- development to ultimate values;
- changes in circumstances;
- seasonality and cyclicality;
- product reform; and
- shifts in the mix of business.

11.1 Development to ultimate values

When using historical claims data to estimate trend, the actuary would typically adjust the data to reflect the potential for future development. For example, it is common practice to develop claim counts and losses (including ALAE) to their estimated ultimate values. Alternatively, the actuary may use data that is at a consistent maturity prior to ultimate.

It is beyond the scope of this educational note to discuss considerations related to the projection of ultimate values. Nevertheless, in trending procedures, the actuary would consider the inherent uncertainty associated with the estimation of ultimate values. Especially for long-tail coverages, the actuary would consider the uncertainty associated with the most immature exposure periods in the experience period. When dealing with immature exposure periods, the actuary may apply judgment such as excluding or assigning limited weight (i.e., credibility) to the most recent exposure period.

The actuary would also consider if development is required for exposures, particularly when using earned premiums. For some lines of business (such as general liability insurance), the actuary frequently uses earned premiums as a proxy for exposures. For analyses conducted with data aggregated by policy or underwriting year, the actuary would typically develop premiums to an ultimate basis similar to the development of claims (i.e., losses and claim counts).

11.2 Changes in circumstances

The actuarial *Standards of Practice* identify “changes in circumstances” as a consideration in P&C insurance ratemaking: “The actuary would consider that the subject experience, related experience and future cash flows may be affected by changes in circumstances that may affect

expected claim costs, expense costs, and provision for profit."[6] Consideration of circumstances and changes in such are also required in subsection 2220 Claim liabilities. The *Standards of Practice* identify potential internal changes such as:

- the insurer's underwriting practice;
- its claims handling practice, including case estimate practice;
- its reinsurance;
- its data processing;
- its accounting;

and as a result of external changes, such as inflation and changes in:

- the legal, regulatory, and legislative environment; and
- residual mechanisms, such as the Facility Association.[7]

In the specific context of trending procedures, changes in circumstances may be sudden or gradual, either of which may result in a change in the underlying data patterns analysed in trending procedures.

The actuary would exercise considerable judgment when considering the influence of a particular change in circumstances on loss trends and the possibility that the particular change in circumstances may also have an influence on, and therefore need to be recognized in, the modelling of the corresponding exposure trend.

If the actuary uses premiums as a proxy for exposures, the actuary would adjust the premiums to reflect a consistent rate level and to exclude the effect of any other changes that are not appropriate to include in the analysis of trend.

When using a long experience period, data from older exposure periods may not reflect more recent changes in circumstances. The actuary has the option of adjusting the model to accommodate such changes, or to adjust the data. A challenge associated with adjusting the data, however, includes a potential increase in the measurement uncertainty of the trending procedures. Thus, the actuary would consider whether adjusting the data is preferable to estimating changes in circumstances within the trending procedures (i.e., methodology or model) itself.

11.3 Seasonality and cyclicality

For many of the major P&C insurance lines of business in Canada, there are recurring seasonal patterns to claims data across successive calendar years. For example: ice storms are common in the winter, floods in the spring, wildfire in the summer, and hurricanes in the fall. All of these can affect claims arising from property, automobile, and general liability coverages.

Given the influence of weather on P&C claims, the actuary would typically review the data for seasonality, particularly if using data aggregated by quarter or semi-annual periods. Without

[6] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraph 2620.05, accessed April 18, 2021.
[7] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraph 2220.07, accessed April 18, 2021.

appropriate recognition of seasonality in trending procedures, the underlying seasonal data patterns may result in statistical noise that is not otherwise explained by the trending procedures. The actuary has choices in either adjusting the data or adjusting the methodology and models used in trending procedures to recognize the seasonality of data.

Seasonality is a special case of the more general concept of data cyclicality, which is typically seen by a recurring data pattern spanning a period longer than one year. The actuary would consider the influence on the derivation of estimated trends of any cyclicality in the historical experience.

Longer-term cyclical patterns in data (such as the commercial lines hard market) may be hard to identify without consideration of a very long experience period, particularly if the cycles are of varying terms. Depending on the length of the forecast period, the importance of considering cyclicality varies. The use of a historical experience period that encompasses something less than a full cycle could affect the estimation of trend. For a short forecast period, the actuary would consider, either judgmentally or through adaptation of the trending procedures, the possibility of an expected data pattern changes due to cyclicality. For example, the addition of a statistically significant independent variable to explain observed cyclicality may strengthen a regression but will require a reliable and unbiased projection for that independent variable to support projecting of future loss costs.

11.4 Product reform

A sudden change due to product reform can affect a loss cost trend analysis when using time as an independent variable, possibly resulting in the following:

- A change in level (or vertical shift) in the data: For example, a legislated change in the automobile insurance policy limit for third-party liability claims occurring after a certain date could result in an increase or decrease in severity.
- A change in trend (or slope) of the data: For example, a legislated change in the automobile insurance policy could result in an expansion of accident benefits coverage for losses occurring after a certain date, such that the financial implications of an insured event are subject to different inflationary forces than observed previously.

When a product reform-related change is expected to have an immediate effect at a known point in time, the trending procedures used for the combined pre- and post-reform data could be adapted. For example, the actuary could use linear regression with independent variables for change in level and change in trend. In such a situation, the actuary would exercise professional judgment to assess if sufficient and reliable post-reform data are available.

Estimates of trend immediately following product reform are often highly sensitive to the relatively short history of available post-reform data that, because of the immaturity and effect of the product reform, are subject to increased measurement uncertainty. Prior to the availability of sufficient post-reform data, *a priori* estimates for regression coefficients could be used for trending procedures. For example, the actuary could restate post-reform experience to a pre-reform basis, run the trending procedures, and then re-apply the *a priori* estimates.

Alternatively, the actuary could introduce further independent variables into the trending procedures.

Modelling becomes more complicated if the impact of the reforms is not clearly delineated at a specified point in time. Additionally, the actuary would consider if the product reform also affects all open claims as of the reform date.

11.5 Shifts in the mix of business

As noted, trend would be measured for a constant portfolio of claims. As a result, if trend is being estimated using an insurer's data, then changes in the risk portfolio generating that data would be considered in the analysis. For example, if the distribution of low severity risks increased relative to high severity risks, a model based on that data might indicate a lower trend rate than would be appropriate.

12. Frequency and severity analyses

Based on the data available and considerations of changes in the circumstances, actuaries develop trending procedures for loss ratios (losses divided by earned premiums), loss costs (losses divided by earned exposures), and separately for the frequency and severity components of loss costs. For P&C insurance, there can be tremendous value in conducting trending procedures separately for frequency and severity of claims. Such analyses require access to both loss data, such as paid or reported losses (including ALAE), and claim count data, such as closed and reported counts. Frequency is typically defined as claim counts relative to exposures, and severity is defined as the average loss per claim (i.e., losses divided by claim counts).

By separately focusing on frequency and severity, the actuary is able to isolate the fundamental cost drivers of P&C claims. The objective of such analysis is to enhance the estimates of the underlying trends the actuary uses to adjust historical losses from the experience period to the cost level (recognizing economic and social inflation) expected in the forecast period. However, unless frequency and severity are statistically independent, the results of combining trends from separate frequency and severity models to estimate loss cost trends can produce spurious results.

13. Outliers

An outlier is an unusual observation or an observation that differs significantly from the general dataset. An outlier may not have a material influence on the trending procedures. Just because a data point seems unusual does not necessarily suggest the actuary would exclude it. An unusual value could simply be an indication of the variability in the data and hence for potential error in the parameter estimates. Ideally, the actuary would be able to isolate the cause of an outlying data point (e.g., catastrophic weather, large loss). It is often the case, however, that the cause is unknown, particularly when dealing with industry data.

The actuary has options for dealing with outliers including capping, excluding, or fitting with a variable in the trending procedures. If the actuary applies a capping approach, the cap would be high enough to avoid disguising underlying trend and to allow the identification of remaining trend. In general, the cap selection only affects severity trends. The actuary has the option to

conduct trend analysis by layer as an alternative to capping large claims. When conducting trend analysis on excess layers, the actuary would consider the development of losses and the sufficiency and reliability of data, particularly given the sparsity and resulting variability of data at higher layers.

14. Selection of trending procedures

The actuary would select trending procedures after appropriate consideration of available data. In selecting these procedures, the actuary would consider relevant information such as:

- procedures established by precedent or common usage in the actuarial profession;
- procedures used in previous analyses;
- procedures that predict insurance trends based on insurance, econometric, and other non-insurance data; and
- the context in which the trend estimate is used in the overall analysis.

Actuarial judgment plays an important role in the analysis of trend. The use of informed judgment can be applied in the trending procedure, including but not limited to, selection of the time periods, inclusion/exclusion of data points, deviation of loss trend selection from model results, and selection of future trend rate (whether the future trend may or may not be a continuation of the past trend).

The actuarial *Standards of Practice* state in subsection 1140: "A judgment that is completely subjective would not be reasonable even though it may be based on honest belief."[8] Therefore, the actuary is expected to exercise informed judgment to arrive at the best estimate of loss trend rate. Similar to other actuarial assumptions, an actuary's best estimate of loss trend rate is expected to be unbiased, neither conservative nor unconservative.

15. Model validation and peer review

As with any model, the actuary would take reasonable steps to ensure that the model is performing well at predicting future values.

To ensure a trend model is robust and sound, validation would be considered throughout the modelling process:

- Model inputs: Data would be reviewed and validated to avoid issues such as inaccurate, inappropriate, insufficient, incomplete data, and misuse and/or misunderstanding of data.
- Model processing/computation: Model assumptions/judgment would be assessed and validated, and independent review could be performed to avoid inappropriate specifications, or calculation errors.
- Model outputs: Validation would be performed to avoid erroneous implementation, (inappropriate, improper, or unintended usage of the model, or misinterpretation of the model results). Model performance would be monitored periodically to evaluate

[8] https://www.cia-ica.ca/publications/publication-details/sc120120, paragraph 1140.04, accessed June 13, 2021.

whether the trend model performs well with emerging data and to help identify weakness and potential opportunities to improve the current trending procedure.

Moreover, to ensure a trend model is robust and sound, it is essential that all participating stakeholders and their respective responsibilities are clearly defined, and that adequate accountability mechanisms are established. Consistent with subsection 1460 of the *Standards of Practice*, quality assurance processes may include self-checking of the work, repetition of the work, and peer review.

To assess the robustness of the trending procedure, the actuary would consider model validation techniques such as time-based cross-validation. For example, estimating the model parameters excluding the most recent exposure periods and testing the trend model against these out-of-sample periods would allow the evaluation of how the model developed applies to actual results.

Retrospectively, the actuary could compare the accuracy of forecasted values from previous analyses with the actual ones. Understanding the differences between previous estimates and the data that have emerged can highlight some weaknesses of the prior trend model, most notably overfitting of the training data, and help identify opportunities to improve the current trending procedure.

16. Documenting and reporting

In compliance with subsection 1490 of the *Standards of Practice*, the actuary would prepare and retain appropriate documentation regarding the data, assumptions, methods, and trending procedures. The documentation would be in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work.

Section 1700 of the *Standards of Practice* addresses the requirements of the actuary for external user reports (1710), internal user reports (1720), and oral reports (1730). For trending procedures, the actuary would disclose the following, as applicable, in reports to users of their work:

- The intended purpose(s) or use(s) of the trending procedure, including adjustments that the actuary considered appropriate in order to produce a single work product for multiple purposes or uses, if any.
- Significant adjustments to the data or assumptions in the trending procedures that may have a material impact on the result or conclusions of the actuary's overall analysis.
- Any material assumption or method that was prescribed by applicable law (legislation, regulations, or other legally binding authority).
- The actuary's reliance on other sources and if the actuary disclaims responsibility for any material assumption or method selected by a party other than the actuary.

When the actuary specifies a range of trend estimates, the actuary would consider reporting on the basis of such range provided. Finally, the actuary would consider reporting changes to assumptions, procedures, methods, or models that the actuary believes might materially affect

their results or conclusions as compared to those used in a prior analysis, if any, performed for the same purpose.