Premium Trend Revisited

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Abstract

Premium trend has been an integral part of the ratemaking process. The *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* lists it in its enumeration of considerations for trends. However, current models for estimating the premium trend have been limited to an exploration of changes in the base exposure. Limiting the premium trend to simply reflect changes in the base exposure can produce a biased indication, as internal loss trends implicitly reflect distributional shifts underlying the rating plan, while the exposure based premium trend fails to incorporate such changes. A methodology for determining premium trend that expands beyond the traditional methods is discussed and the theory underlying the proposed methodology is developed.

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Premium Trend Revisited

David Brockmeir has written a paper entitled *Homeowners Premium Trend* [1]. Brockmeir's paper discusses different methodologies for adjusting Homeowners' premiums to bring them to current coverage levels. While Brockmeir's Static II Method and Dynamic Method are improvements over the static method traditionally used in property ratemaking procedures, they still are an incomplete model for adjusting Homeowners premiums. This paper will discuss some of the weaknesses of current premium trend procedures employed in the property lines, provide an alternative method, and demonstrate how this alternative premium trend method can (and why it should) be applied to other lines of business.

A Very Simple Example

Consider the following very simple example of the normal process followed in a typical rate review. For simplicity, let us assume that these are private passenger automobile, bodily injury, basic limits, single class (i.e. adult operators) data. The basic data outlined below would first be obtained.

Table 1
Premium and Untrended Losses For Indication

Year	Premium @ Present Rates	Developed Losses	Loss Ratio
A	428,571	300,000	70.0%
B	442,857	310,000	70.0%
C	457,143	320,000	70.0%

In the table above, the losses are not trended. The following data, internal to the book of business, are used to trend the losses.

Table 2
Trend Data[1]

Year	Exposures	Paid Losses	Pure Premium
A	2,000	300,000	150
B	2,000	310,000	155
C	2,000	320,000	160

The above data generate a trend of approximately +3.3%. The losses would then have the trend applied to them and the overall (generally, statewide) indication would be developed. Table 3, below, summarizes the development of the trended loss ratio at current rates which would be used to develop the indication.

Table 3
Premium and Trended Losses For Indication

Year	Premium @ Present Rates	Trended and Developed Losses	Loss Ratio
A	428,571	341,604	79.7%
B	442,857	341,714	77.2%
C	457,143	341,468	74.7%
Total	1,328,571	1,024,786	77.1%

If the company has a permissible loss ratio of 70%, and all expenses are variable, then a +10.1% rate increase is indicated.

[1] The general standard for automobile ratemaking is to use at least twelve quarters of fiscal calendar year paid data, and regress. However, only three years calendar years are used as the example is intended to remain simple

The next step in this very simple rate review would be to perform a territorial analysis. Table 4, below, summarizes data needed to perform the territorial analysis.

Table 4
Territorial Premium and Loss Data

	--- Territory A ---			--- Territory B ---		
Year	Premium	Pd Losses	Loss Ratio	Premium	Pd Losses	Loss Ratio
A	285,714	200,000	70.0%	142,857	100,000	70.0%
B	314,286	220,000	70.0%	128,571	90,000	70.0%
C	342,857	240,000	70.0%	114,286	80,000	70.0%
Total	942,857	660,000	70.0%	385,714	270,000	70.0%

From the data above we can see, upon application of standard loss ratio analysis, that no change is indicated for the territorial relativities.

The Problem

In the above example, each of the three years had 70% untrended, developed loss ratios at present rates. Similarly, in each year each territory had a 70% loss ratio. However, a positive +3.3% annual loss trend, developed using the data internal to the book of business has generated an overall indication of +10.1% for the line.

An examination of the territorial data in Table 4 shows that the premiums at present rates are increasing in Territory A, while in Territory B the premiums at present rates are decreasing. Table 5, below, summarizes the exposures which underly the premiums and losses in Table 4.

Table 5
Exposures Underlying Territorial Premium and Loss Data

Year	Territorial Exposures A	B	Total
A	1,000	1,000	2,000
B	1,100	900	2,000
C	1,200	800	2,000

Table 5 shows that, although the total exposures have remained unchanged over the experience period, there has been a shift away from Territory B to Territory A. (One can verify readily from the data in the above tables, that the base rate used to calculate the Territory A premiums at present rates is $285.71, and that the base rate for Territory B is half that of Territory A.) The loss trend developed using the data in Table 2 is misleading. Although the average losses for the book are increasing annually, there is no economic or social trend which is driving the increase in the average loss costs. Instead, a demographic shift, which may or may not be peculiar to the company, from one territory to another, is driving the change in the average loss costs. Since the base rates anticipate the cost differentials which exist between these territories the formula for developing the rate level indications must be revised, so that an overall loss trend which is reflecting only a demographic shift does not drive the indications.

A Discussion of the Alternatives

Most actuaries may feel somewhat insulted by the example, and state that they would recognize such a shift, and make allowances for it. However, the

preceding section where the indication is developed is entitled "A Very Simple Example" for good reason. In the real world, pricing is not as simple as that which is shown in the example. Random variation in the losses frequently obscures relationships like those which are so readily evident in this simple example. Rarely will one encounter a situation wherein there is absolutely no social or economic inflation impacting a line of insurance like that shown in the example. Additionally, business pressure to complete one rate review, and move on to the next one, can create an environment wherein time constraints inhibit both the discovery and exploration of shifts akin to that created above.

Can an actuarial model be developed that accounts for the bias in our ratemaking model caused by the shift in the distribution of exposures by territory?

Three alternatives are readily available:

1. **Eliminate Loss Trends from the Indications**

   This is not a realistic option. Although "A Very Simple Example" has shown that bias can be introduced into the indication with a simple distributional shift, the complete elimination of the loss trend to address such shifts replaces a ratemaking process with one bias with a ratemaking system with a new bias. That is, if inflationary and / or demand shifts are occurring in the book if business, then an indication that ignores these economic forces is a biased indication, albeit with a

different bias. Additionally, the proposal to eliminate loss trends from the ratemaking process is a non-starter as it is contrary to the "Statement of Principles Regarding Property and Casualty Ratemaking".

2. **Temper the Loss Trends by Reflecting Known Shifts which Impact Losses:**

This would appear to be a desirable solution. That is, as in the case of the Very Simple example, one could weight the denominator of the pure premiums with the territorial relativities. However, the complexity of this solution makes it undesirable.

First, these indications were developed with pure premium trends only. Suppose one wishes a more complete analysis of the loss trends through the exploration of both the changes in the inflationary impact (severity trend) and the changes in the demand impact (frequency trend) on the book of business.[2] This would require recognition of both the severity and frequency impacts in the development of the territorial relativities. Thus, to completely analyze severity one would need a severity based relativity to weight the claims, and a frequency based

[2] Diamantoukos [2] recognizes the need for separate analysis of exposure related to both frequency and severity is his discussion of Bouska. "The best solution to approximating the true exposure in some cases might be to utilize more than one exposure base. Two exposure bases might be used, one for frequency and the other for severity."

relativity to weight the exposures, a very complex requirement.

Second, the Very Simple Example considered the book of business to be written only for a single class of insureds. That is, our simplifying assumption was this book was comprised of basic limits, single class data. If a book of business has a mix of classifications / dimensions, then relativities that are both frequency and severity based need to be available by all the classifications / dimensions.

The need to weight the denominator of the loss trends with frequency and severity based relativities make the appropriate adjustment to the loss trends quite problematic, making this alternative undesirable.

3. **Don't Adjust the Loss Trend, but Develop a More Sophisticated Premium Trend, which Reflects All Premium Related Changes:** The territorial relativity is part of the premium charge. The intent of introducing a premium related trend into the indication, which reflects the territorial differences in our example, is to provide a financial statistic to state our premium and loss projections on a more common level. Such an adjustment should eliminate, or significantly reduce, the bias seen above. As premium trend is a consideration explicitly enumerated in the "Statement of Principles Regarding Property and Casualty Ratemaking", the inclusion of such a trend in indications

previously lacking premium trend, or an improvement upon current premium trend procedures, result in indications that better comply with ratemaking principles.

A More Sophisticated Premium Trend

It was proposed above that incorporating a more sophisticated premium trend procedure into the ratemaking process will accomplish the desired effect of eliminating the bias in our indication.

The proposed premium trend is simply the average premiums at present rates. The use of the average premiums at present rates eliminates much of the bias in the indication. A theoretical justification for its use is provided later in the paper.

The use of this procedure is a departure from traditional methodologies. Traditionally exposure trends have been used as a surrogate for premium trend. Bouska [3] requires that the exposure base have a continuous, linear, multiplicative relationship to the losses. Homan [4] develops a premium trend which considers only amount of insurance which is comparable to the Static Method I discussed by Brockmeir. Chernick [5] reflects in Private Passenger Auto Physical Damage the "linear" nature of model year. Feldblum [6] discusses the impact of changes to payroll in developing a premium trend for

Workers Comp. While for General Liability, Graves and Castillo [7] discuss the use of payroll and receipts in premium trend.

The actuarial goal of developing a premium trend with each of the above is to account for the changes to income emanating from a change in the exposure base. However, the use of the term "Premium Trend" is a misnomer, insofar as it fails to account for the impact of variables that act upon both historic and projected collection of revenue. That is, to the extent that the premium trend fails to recognize the impact that changes in the distribution of insureds across classifications has upon the collection of income (i.e. premium), it fails to adequately represent the change to premium.

In discussing the exposure base, Bouska commented upon what the exposure base was not. She stated that the exposure base was not a rating variable, and noted that, unlike the exposure base, a rating variable has a discrete, non-linear relationship. If these discrete, non-linear relationships are changing over time, then failing to account for them in lines where a traditional exposure based premium trend is included in the indication, generates a biased premium trend, and, hence, a biased indication. In "A Very Simple Example" we also see that failing to account for the change in the distribution of discrete, nonlinear relationships in a line of insurance that has not incorporated premium trend in its development also generates a biased indication.

Let us close this section with a restatement of the Very Simple Example using a premium trend based upon the average premium at present rates. Table 6, below, summarizes the average premiums at present rates.

Table 6
Average Premiums at Present Rates

Year	Prem @ Prst Rate	Exposures	Avg Prem @ Prst Rt
A	428,571	2,000	214.29
B	442,857	2,000	221.43
C	457,143	2,000	228.57

The average premium at present rates increases annually at +3.3%, which should not be surprising, given that the loss trend was identical and driven solely by the territorial distribution shift. The revised loss ratios for the indication, using the premium trend, are developed below in Table 7.

Table 7
Revised Loss Ratios Using Premium Trend

Year	Trended Prem @ Prst Rates	Trended and Developed Losses	Loss Ratio
A	488,005	341,604	70.0%
B	488,163	341,714	70.0%
C	487,812	341,468	70.0%
Total	1,463,980	1,024,786	70.0%

Given the previously stated permissible loss ratio of 70%, no change is indicated.

A Theoretical Justification

The above resolution of the indications developed from "A Very Simple Example" produces a result that is intuitively appealing, but does not provide a rigorous justification for the use of average premiums at present rates for premium trend.

To provide a justification, we return to our initial example. Let us break down the components of the total premium the year *i* in territory *j* (P_{ij}) into its basic components.

Let

x_{ij} = The exposure for year *i* in territory *j*;
t_j = The current territorial relativity for territory *j*;
n = The number of territories; and
r = The current base rate

Then the premium in year *i* for territory *j* is

$$P_{ij} = r * t_j * x_{ij}$$

The total premium in year *i* is

$$P_i = \sum_{j=1}^{n} r * t_j * x_{ij} \qquad (1)$$

In "A Very Simple Example" there is no inflation over time, and the territorial relativities are perfectly priced. We define the loss cost drivers as follows:

Let

f_{ij} = The frequency in year *i* for territory *j*; and
s_{ij} = The severity in year *i* for territory *j*[3].

Thus, the losses in year *i* for territory *j* (L_{ij}) are

$$L_{ij} = f_{ij} * s_{ij} * x_{ij}$$

Then the total losses for year *i* (L_i) are defined by the equation

$$L_i = \sum_{j=1}^{n} f_{ij} * s_{ij} * x_{ij} \qquad (2)$$

In our simple world with no inflation, let us assume that our territorial relativities are defined using pure premiums (i.e. there are no fixed expenses). Let z represent the base territory. Then the territorial relativity for territory j is defined by

$$t_j = \frac{f_j * s_j}{f_z * s_z} \qquad (3)$$

Let us now incorporate (3) with (1) and (2) to develop a loss ratio for a year i.

$$L_i / P_i = \sum_{j=1}^{n} (f_{ij} * s_{ij} * x_{ij}) \Big/ \sum_{j=1}^{n} r * [(f_{ij} * s_{ij}) / (f_{iz} * s_{iz})] * x_{ij} \qquad (4)$$

[3] In the example, the loss costs do not vary by year, so that at this juncture differentiating the frequency and severity by year is superfluous; however, as we expand upon the example, the ability to differentiate frequency and severity by year will become important.

Because we are considering only a single year's experience, we can drop the *i* subscript, and (4) can be simplified to

$$L_i \;/\; P_i = (f_z * s_z) \;/\; r \qquad (5)$$

Equation (5) is simply the base territory's pure premium divided by the base rate. This is the permissible loss ratio, which comports well with the data seen in "A Very Simple Example". That is, in our non-inflationary environment where the product is properly priced by territory, we would expect that the loss ratio would equal the permissible loss ratio.

Now, consider the impact of our earlier application of loss trend in "A Very Simple Example". Let us, for simplicity, consider the loss trend as a one year ratio of the pure premiums. Then we define our loss trend factor, *q*, where x_i represents the total annual exposures, as

$$q = \left[\left(\sum_{j=1}^{n} (f_{(i+1)j} * s_{(i+1)j} * x_{(i+1)j})\right) / x_{(i+1)}\right] \Big/ \left[\left(\sum_{j=1}^{n} (f_{ij} * s_{ij} * x_{ij})\right) / x_i\right]$$

But frequency and severity in our non-inflationary world are the same for the years i and (i + 1), so that our loss trend simplifies to

$$q = \left[\left(\sum_{j=1}^{n} (f_j * s_j * x_{(i+1)j})\right) / x_{(i+1)}\right] \Big/ \left[\left(\sum_{j=1}^{n} (f_j * s_j * x_{ij})\right) / x_i\right] \qquad (6)$$

If we multiply (6) by unity in the form of [(r/ $f_z s_z$)] / [(r/$f_z s_z$)] both the numerator and the denominator are converted to premiums at present rates. Using the relationship in (3) we define our premium trend factor, *p*, for simplicity, as a one year ratio of premiums at present rates.

$$p = \left[\left(\sum_{j=1}^{n} (r * t_j * x_{(i+1)j})\right) / x_{(i+1)}\right] / \left[\left(\sum_{j=1}^{n} (r_j * t_j * x_{ij})\right) / x_i\right] \quad (7)$$

Thus, after multiplying the loss trend by unity, we obtain the premium trend and can see that in this non-inflationary environment the loss trend equals the premium trend. Given our simplifying assumptions about the book of business, our premium trend simply reflects the change in average territorial relativity. In this non-inflationary environment when we apply the loss trend (6) to the loss ratio (5), we can now see that we are simply adjusting the permissible loss ratio to reflect the change in the average territorial relativity. A biased indication results when we fail to adjust the premiums for this change in average territorial relativity.

A Return to the Real World

"A Very Simple Example" had four assumptions that are not encountered in the real world.

1. Products are priced with more than one rating variable.

2. Products are not perfectly priced to begin with.[4]
3. Loss trends do occur in the real world.
4. Random fluctuation occurs.

With regard to multiple rating variables, the equations above can be adjusted to account for them, and the resultant multiple summations yield the same result.

With regard to products not being perfectly priced, we can introduce an error component, e_j, into our loss equation (2). This error component varies by territory, under the assumption that each territory has the potential to be inaccurately priced. Note, however, that it does not vary by year, since the current relativities are being applied to bring the premiums to present rates.

To account for loss trends we introduce the loss trend component, q_{ij}, into loss equation (2). This trend component accounts for both the demand and inflationary changes. If one wanted to account for frequency and severity changes independently, then two such components could be introduced. Note that we have allowed the demand and inflation changes to vary both by year and territory. From experience we know that inflation is not constant over time and that it can vary regionally.

[4] Some might argue that this assumption is not true, working for a company that always takes its fully credible indicated rates. But even a company that does such in the competitive insurance market place still is not guaranteed it charges the "correct" rate. For a fully credible rate using the classic 1,082 full credibility standard is still not "perfect". The company adopting such a rate is still only 90% confident that is within 5% of the correct rate.

Random fluctuation in the losses can be accounted for with the component R_{ij}.

Thus, we can now restate the losses for year *i* in terms of components that occur in the real world.

$$L_i = \sum_{j=1}^{n} R_{ij} * q_{ij} * e_j * f_j * s_j * x_{ij} \qquad (8)$$

The frequency and severity components in (8) represent the *a-priori* average loss costs that would be assumed when the initial rate review began, and thus do not vary by year. Dividing two consecutive years of average losses produces the change in average annual losses. One would face an enormously complex task if required to develop the random error, trend, and pricing components independently. However, if one were to divide the ratio of the average annual losses by the change in average premium, then one would have the change in losses not attributable to premium trend, or, a pure loss trend. Thus we can define the pure loss trend, for a year[5], *Q*, as the ratio of the loss trend divided by the premium trend. Thus, using our knowledge that f_j and s_j do not vary by year and the relationships implicit from (6) we obtain

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[5] This concept of a "pure loss trend, for a year" is an extremely poor term. A trend cannot be developed using two years of data. This term has been created for illustrative purposes only for the ensuing equation. Realistically, the pure loss trend would be developed by dividing a selected loss trend, developed using more than two points, by a premium trend developed using multiple years of points.

$$Q = [\ (L_{(i+1)} / x_{(i+1)}) / (L_i / x_i)\ ] \ / \ [\ (P_{(i+1)} / x_{(i+1)}) / (P_i / x_i)\ ]$$

$$= \frac{\left(\sum_{j=1}^{n} R_{(i+1)j} * q_{(i+1)j} * e_j * f_j * s_j * x_{(i+1)j}\right) / \left(\sum_{j=1}^{n} R_{ij} * q_{ij} * e_j * f_j * s_j * x_{ij}\right)}{\sum_{j=1}^{n} \left(f_j * s_j * x_{(i+1)j}\right) / \sum_{j=1}^{n} \left(f_j * s_j * x_{ij}\right)} \qquad (9)$$

Before the premium trend procedure was introduced, a potential alternative for addressing the bias in "A Very Simple Example" was to *"temper the losses by reflecting known shifts which impact losses"*. Dividing the loss trend by the premium trend provides such a tempered loss trend (9), our pure loss trend.

Thus, the use of premium trend developed using average premiums at present rates provides two important tools to the actuary and company management. First, analysis of the premium trend provides information on how the income stream is being impacted by distributional shifts. Second, dividing a traditionally developed loss trend by the premium trend, provides information on how average loss costs are changing independent of distributional shifts accounted for in the premium.

Before closing out this section, let us consider an additional advantage to using the average premiums at present rates for premium trend. Homan develops Homeowners indication using the $100 deductible. For other lines of insurance,

such as private passenger physical damage, this procedure is also employed. An advantage to the recommended procedure is that it eliminates the need to either adjust premiums and losses to a common deductible or examine only a particular deductible's experience. The inclusion of all deductible experience eliminates a bias in the overall rate level indication. Implicit in the use of a single deductible is the inference that the deductible relativities are correct. If this inference is incorrect, then the overall indication is biased by the error in the deductible relativities[6].

Assume, for example, that the higher deductibles are inadvertently underpriced. Then a statewide indication developed at the $100 deductible would understate the overall rate need. While the appropriate action would be to analyze the deductibles (and, for that matter, every rating variable) at every review to ensure proper rating, time constraints frequently prohibit such analysis. Thus, the recommended premium trend procedure, while creating subsidies within rating variables, still enables the overall correct premium to be developed.

The Trend Period

In Homan, the premium trend is extended to the average day of writing for the period in which the rates will be in effect. Under the proposed methodology, the premium trend has been calculated using the average earned premiums at

[6] If pricing analysis is performed with low deductibles, this is even more problematic, since large deductibles are subject to significant leveraging of their losses in an inflationary environment (Hogg and Klugman [8]).

present rates. For consistency, the trend is extended from the average date of earning in the experience period to the average day of earning in the period for which the rates will be in effect.

Written premiums could be used for the determination of the premium trend. In this example, the earned premiums at present rates have been determined by multiplying the earned exposures by the current base rates and relativities. The primary disadvantage to using the average written premiums at present rates is the need for additional calculation, if the earned premiums at present rates are calculated using the earned exposures.[7] If written premiums at present rates are calculated, and used to determine the premium trend, then the trend period extends from the average day of writing in the experience period to the anticipated average day of writing for the period for which the rates will be in effect.

Measuring Premiums at Present Rate Levels

We have seen how the use of premiums at present rates can produce a more accurate premium trend. The methodology to develop the premiums at present

[7] This need for additional calculation stems from the inherent mismatch that occurs in any comparison of earned premiums to written exposures. That is, the rate of change is a function of the exposure base, and in a dynamic book of business the rate of change measured using written exposures can be different from the rate measured using earned exposures. If the rate of change is different between the written and earned exposure bases, additional calculations are required to both approximate this difference in the rate of change, and adjust written rate to an earned rate. Of course, if the earned premiums at present rates are calculated using written exposures that are re-rated and then the written premiums are earned no additional calculation is needed.

rates should be the extension of exposure technique.

It is still common for premiums to be brought to present levels using the geometric or parallelogram technique described by McClennahan [9]. Using average premiums at present rates developed with the geometric method to determine the premium trend produces distorted results.

The parallelogram method presupposes an even distribution of writings. Historically, when this even distribution of writings has been discussed it has been more in reference to the timing of when risks are written (i.e. whether they are written evenly throughout the year or whether seasonality impacts the level of writings). Implicit in the even distribution of writings presupposed in the parallelogram technique is the even distribution of the types of policies being written.

When the rate changes that underlie the parallelogram technique are measured, they are measured against the distribution of risks in effect at the time of the proposed rate change, frequently the most recent year's written premiums at present rates. The parallelogram technique applies that change to past writings, with the application of an overall change to the premiums implicitly assuming that the distribution of rating variables in effect historically is the same as the distribution of rating variables when the rate change was measured. If any rating variable distributional shifts are occurring (e.g. amount of insurance,

class, deductible) then the average premiums at present rates developed with the parallelogram technique fail to capture the complete nature of the change to the income stream.

If the resources are unavailable to completely rerate a book of business using the current rate manual, then the change in current average premium relatitivities can be applied to the average premiums at present rates developed with the parallelogram technique to obtain a more complete approximation.

Loss Trend Issues

Let us consider for a moment the traditional property ratemaking procedure. In a traditional property ratemaking process the premium trend has been limited to an exploration of changes in the dwelling coverage amounts (Brockmeir and Homan). That is, the ratemaking methodology has considered the change in the exposure base to be the sole contributor to changes in premium income. The loss trend has relied almost exclusively on external trends, specifically, the Boeckh and modified CPI external indices. Since inflationary pressures are driving the changes in coverage amounts, the traditional ratemaking procedure has contemplated the need to balance the changes in premium income with the changes in losses as measured with external indices[8]. However, to the extent

[8] Note, however, that even if the external indices measure cost inflation perfectly, they still may not be a reliable surrogate for loss trends.

that non-coverage amount[9] distributional shifts are impacting the premium income, the traditional property ratemaking process may be biased.

Consider a book of business that, in addition to coverage level changes, is experiencing a shift to higher deductibles, lower cost territories, improved protection classes, and a construction-type shift from Frame to Brick. Each of these shifts has a downward impact on premium income. The traditional premium trend calculated using the changes in coverage amounts (i.e. tempered or non-tempered amount of insurance relativity changes) should be modified by the changes in each of the aforementioned relativities. However, if the loss trend is not also modified with these non-coverage related relativity changes, then the indication would be overstated.

Assume that the non-coverage related relativities each produce –2% annual

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First, they fail to account for changes in demand / frequency. That is, they do not reflect how the claims process is impacted by increasing or decreasing claims consciousness on the part of the insurance consumer.

Second, the indices do not necessarily reflect claims inflation, but overall inflation. For example, the Boeckh index is used to measure how total building costs are changing over time. In property insurance few claims are total losses. Thus, there is a potential mismatch between the claims process, which is driven by partial losses, and the external index, which addresses total building costs. Consider a state where the predominant type of claim is roof losses from hail. If the components of roof construction are inflating more rapidly than the other component costs of building, then the loss trend would be understated, as equal weight is given to the roof and non-roof components in the external index, but the claims process is more heavily weighted with roof material purchases.

Finally, they fail to account for rate related distributional shifts.

[9] Coverage Amounts are considered to be the dwelling face amount throughout this discussion, because the traditional premium trend procedure relates solely to the dwelling face amount. Note that although the deductible impacts the amount of coverage an insured possesses, for purposes of this discussion deductible is not included under the "coverage amount".

change in premium. Then their combined effect reduces premium income –7.8% annually. As mentioned above, applying this change to premium trend, but providing no similar adjustment to the loss trend will overstate the indicated rate change. If one assumes that the current rate relativities are correct, then one can apply the change in the non-coverage related relativities to the loss trend to bring the projected premiums and losses to a distributional balance.

Under the assumption that offsetting the selected external loss trend indices with the change in the non-coverage amount relativities, one readily sees that these changes to the relativities offset one another in both the premium and the losses. One might argue that the beauty of the traditional property ratemaking procedure lies in the simplicity of not needing to concern the actuary with the changes in the non-coverage amount relativities. This would be an incorrect assessment on two counts.

First, failing to recognize the non-coverage amount related premium and loss trends can produce a biased indication, even if these non-coverage relativities are perfectly priced. In our example, the non-coverage amount related premium trend is negative. The fixed expenses remain unchanged despite this perfect pricing. Thus, an indication using a fixed expense loading would be understated if the premiums and losses were not adjusted as described. Contrariwise, if the non-coverage related premium trend were positive an excessive rate would be developed without the described adjustment.

Second, the external indices may well provide inaccurate estimates of changes to insurance losses, as they fail to consider changes in demand, the mismatch between the general housing inflation rate and the insurance claims indemnification process, and changes in the distributional mix. Thus, the use of the external indices, while simplifying the ratemaking process, will produce biased indications to the extent that they are an inaccurate surrogate for claims inflation.

Let us consider further the impact of applying the change in the non-coverage amount premium relativities to the external loss trend. The assumption made in applying these changes was that the product was perfectly priced. However, we introduced an error term, e_j, to our loss function, equation (8), because we know that products may not be perfectly priced. Let us assume that our protection class relativity in this property example is inaccurately priced, and that if correctly priced, the change in the protection class relativity would be –3%, rather than the –2% reflected in our current premium trend. Ignoring the random error term in equation (8), if internal loss trends were used, then they would reflect the –3% annual change in loss costs from the protection class distributional shift. That is, the impact of the protection class shift would cause the losses to deflate more rapidly than the premium. Applying the protection class portion of the premium trend to losses assumes that the losses and the

premiums are deflating at the same rate, and will produce an excessive indication.

The preceding paragraph raises a critical issue associated with both the use of internal loss trends and our adjustment to external loss trends, and merits additional amplification. In "A Very Simple Example" there was no loss trend outside the distributional shift by territory. Additionally, the territories were perfectly priced. Consider the component, $(e_j * f_j * s_j * x_{ij})$, from our loss equation (8), where the perfect pricing assumption was eliminated. In successive periods, this component measures the change in losses due to both the change in the distributional shift from the assumed underlying frequency and severity of j (i.e. the assumption that the product is perfectly priced) and the error in the estimated frequency and severity (i.e. the recognition that the perfect pricing assumption is violated). That is, the internal loss trends measure much more than the inflation impacting the claims process. In addition to measuring the impact of inflation upon the book, the internal loss trends measure the change in average loss costs due to distributional shifts, without regard to how properly these rate-related distributions are priced. The use of external trends fails to consider how changes in the rate-related distributions are impacting the losses, and even with the proposed adjustment, the external indices will not capture changes in losses due to incorrect pricing.

We have outlined problems that exist with the use of external data to use as loss trends in property ratemaking. When the proposed premium trend procedure is applied to the premium, the need to reflect the changes in losses due to distributional shifts introduces additional difficulties. Thus, it would appear that internal data would provide a more accurate indication. Traditionally, external loss trends have been used in the property ratemaking process, in part, because catastrophic claims make internal data difficult to use. McCarthy [10] provides a method through which catastrophes can be removed from property data, enabling the development of loss trends using data internal to the book of business.

The adjustment to the premium trend procedure has applied the non-coverage amount distributional changes to both the premiums and losses. This was done under the assumption that the coverage related premium changes and the external loss trends were measuring similar issues related to inflation. This requires a two-step premium and loss trend procedure. An additional advantage to using internal loss trends is that the premium trend and loss trend procedures are simplified

Observations

Brockmeir's Static Method II and Dynamic Method provide more accurate methodologies for ascertaining the impact to premium of coverage level (i.e.

amount of insurance) changes in the Homeowners line of business. However, they fail to measure the impact to premium of changes to non-coverage related premium-affecting distributions. The proposed methodology provides for a more complete analysis of all the components related to premium.

When one considers the results of personal lines products in the second half of the 1990's, a question arises as to if some of the profitability issues associated with these lines throughout the latter half of the decade are related to a biased ratemaking process. One cannot ignore the impact that increased catastrophes have had upon Homeowners, but even when catastrophes are removed from the experience Homeowners profitability has still lagged Automobile's.

Have population demographic shifts exacerbated Homeowners profitability? If we assume that the growth in Homeowners has come in more urban, highly protected areas, and if the premium projections within the indications failed to account for the reduced revenue associated with this shift, then the indication's projected loss ratios would be understated, and the indicated premiums inadequate. The same population shift would generate results in Auto somewhat akin to those seen in "A Very Simple Example". That is, in Auto the indication's projected loss ratios would be overstated, resulting in excessive indicated rates.

The population demographic shift is but one example of how a ratemaking procedure that fails to account for shifts in average premiums at present levels can result in inaccurate indications. It, by no means, provides a complete explanation of why we see the divergence in these personal lines results as the twentieth century comes to a close.

In Workers Comp and General Liability, adjustments to the premium trend to reflect the changes in classification changes over time at the current rates may result in more consistent internal loss trends. Graves and Castillo note that the ISO is developing external indices to be used in General Liability indications due to a dissatisfaction with the internal data. A more sophisticated premium trend procedure, which accounted for the classification, territorial, and exposure changes may produce more stable and reliable pure loss trends, reducing the need for the external indices.

Although the premiums used in the loss ratio trends for Workers Comp are brought to present rates using the parallelogram method, some of the value of this trend may stem from a partial reflection of changes to classification distributions, that are not part of the general loss trends generally developed for the line. Indeed, the Loss Ratio Trend in Workers Comp resembles the pure loss trend introduced in this paper.

Conclusion

While the model presented should result in the development of more accurate rate level indications, it still is incomplete. The model assumes that all expenses are variable. To the extent that rate relativities reflect fixed expense loadings, there is still a mismatch between the prospective premiums and the prospective losses upon which a rate level indication is based. Additionally, the analysis has used the same exposures for the loss trend as that for the premium trend. The use of the same exposures essentially assumes that the losses are paid immediately upon occurrence, ignoring timing issues associated with the loss payments.

Premium trend has been an integral part of the ratemaking process. However, current models for estimating the premium trend have been limited to an exploration of changes in the base exposure. Limiting the premium trend to simply reflect changes in the base exposure can produce a biased indication, as the loss trends implicitly reflect distributional shifts underlying the rating plan, while the premium trend fails to incorporate such changes. The proposed methodology for developing premium trend is a theoretically sound approach to redress such mismatches.

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