"An Exposure Based Approach to Automobile Warranty Ratemaking and Reserving"

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ABSTRACT: Existing actuarial techniques for automobile warranty ratemaking and reserving rely heavily on emerging experience (loss development) for the pricing and unearned premium reserving of these products. Since terms for automobile warranties can extend up to 10 years, such data is typically not available or not credible to the degree that the actuary can take great reliance on it. In addition, changing coverage terms in the auto warranty products can often make past development even less meaningful. Exposure techniques that have been developed (Cheng, 1993) rely on overall averages for some critical assumptions instead of distributions or individual policy characteristics.

We propose a "miles-driven" approach in which claims are assumed to arise from auto warranties in proportion to the miles driven times a weight assigned to the overall mileage of the vehicle. The method we employ is much more complex than traditional methods, but relies on data that is typically available at warranty writers. Important data elements would include the mileage of the vehicle at the time of a claim and if the contract cancels. In addition, the underlying manufacturer's warranty is also critical.

In order to provide an accurate model of pricing, a distributional approach is utilized for each policy to model the different driving habits of the policyholders. For example, claim costs can be developed using 5 different driving habits for each policy.

Such a method is very useful for the pricing and premium reserving of new coverages or at start-up companies.

The method proposed utilizes "policy-event based loss estimation methodology" in which a predicted claim cost is derived from each warranty individually.

1. The Continuing Problem of Extended Warranty Coverages

Pricing issues continue to plague the extended warranty industry for vehicles, often known as "vehicle service contracts." Some of these issues are due to the structure of the industry which has historically had a low barrier to entry and a significant number of players with capital constraints. As such, the market can attract inexperienced players that are unaware of the complexities of this insurance product.

Warranties may be written as traditional insurance products, or may be in risk retention groups or captives. In some cases, warranties may not be classified as insurance for regulatory purposes. Regulation of warranty products varies widely and is constantly changing. Due to the fragmented nature of the industry and the variety of forms that warranties may take, it is difficult to compile industry level statistics.

The long warranty period gives rise to a long payout pattern that can mask optimistic pricing and reserving assumptions for several years. Terms for automobile warranties can range up to 10 years. For new car coverages, the effective coverage provided by the warranty over this time period is not uniform. For the first several years, relatively few claims are paid as manufacturer's warranty will cover most claims. As the manufacturer's warranties begin to expire, claims will begin to rise dramatically. Claims also should moderate at the end of the contract as many contract holders will "mile out" of their coverage – that is they will drive the allowed miles before the time has expired. In addition, the policyholder may sell or otherwise dispose of the vehicle without transferring the warranty to the new owner.

In general, this paper will use the term "warranty" which is common in the actuarial industry. However, the term "service contract" is increasingly being used in the industry. For the purposes of this paper, these terms are interchangeable.

2. The Structure of Automobile Extended Warranty Industry

Extended warranty or service contract underwriting is structurally different from other property/casualty products and an understanding of the structure and terminology may be helpful for the actuary who is unfamiliar with the business.

Although there are many different models, a common practice is that the extended warranty is sold at the dealership at the time of purchase of a new or used vehicle. Typically, the consumer may encounter several ancillary products which are sold at the time the vehicle is purchased. These would not only include extended warranties, but also pre-paid maintenance, GAP insurance (which covers the difference between the actual cash value and the loan balance at the time of an insurable event if the vehicle is a total loss), VIN etch, etc. These products are almost always financed with the vehicle. Once an extended warranty has been sold, the amount charged for the warranty will be divided into several components. These include:

- Retail markup (for the auto dealer)
- Agent's commission
- Administrator Fee
- Warranty Reserve

An administrator typically will perform all the processing and servicing of the warranty. An agent will represent the administrator to the dealer clients. The warranty reserve is remitted to an insurance company, which may or may not be owned by the administrator. For the actuary, there are two items of note:

1. The terminology of reserve is misleading because "reserve" in extended warranty typically refers to all funds used to pay claims, not just the outstanding portion, and is more analogous to written premium. For our purposes, we will use the term premium.
2. Since the vast majority of expenses are paid prior to the remittance of funds to the insurance company, the expected loss ratio is higher than other property/casualty products. Often, a book will be priced at an expected loss ratio of 95 to 100 percent.

> Because these contracts are generally single premium and long term, there is a significant amount of investment income associated with extended warranties.

While this paper only concerns the calculation of expected loss costs for extended warranties, these techniques could also be used by administrators to recognize their fees in proportion to the expected claims from service contracts.

3. Warranty Exposure Bases

In general, exposure bases are measurements for insurers that tell of the relationship that exists between insurable objects and critical conditions where a claim can occur, that note the proportional size of hazard as measured by the losses (magnitude), and that are preferably practical and already in use. This means that exposure bases should have certain qualities, namely, accurate in measure of exposure to loss, easy to determine, and difficult to manipulate.[1]

The purpose of exposure bases is to determine the exposure to loss for an insurer based on the expected loss determined by a series of accepted calculations in order to use the simple and reliable data to develop correct premiums for the insurer and equitably distribute the premiums among the insureds.

For vehicle service contracts, exposure bases are somewhat unique in that the exposure base used to price and rate the coverage (Miles/Time) is not the exposure base that has been commonly used to evaluate the experience (Projected Claim Reporting Pattern).

Deriving an appropriate exposure base for vehicle warranty coverage is a fundamental question when analyzing this line. Fortunately, changing the exposure base in the analysis of the product does not imply changing the exposure base used to market the product.

- Time (Earned Warranty Year) is a poor choice. Warranty claims are not uniform during the policy period. For an extended warranty sold for a new car, the claims pattern will be especially non-uniform, with few claims arising during the initial period that is covered by the manufacturer's warranty. The majority of claims will occur after the manufacturer's warranty expires. In addition, there will be a drop in claims at the end of the warranty as many vehicles exceed the maximum mileage allowed under the warranty or are sold without the transfer of the warranty coverage.
- Indicated Claims Reporting Pattern – This is the most common exposure base used today. This is formulated by developing incremental pure premiums (Cheng, 1993) or simply developing losses by reporting period. This is typically done by loss triangulation. However, instead of aging the claims since the time of the accident, the age of claims are measured from the inception of the policy. This method is appropriate, however, only if:

    1. There is enough data to make these assumptions. While extended warranty achieves credibility at low volumes due to the high frequency/low severity

[1] See Bouska, 1989

nature of this coverage, there may be limited or no data at the latter points of the coverage being analyzed. If there is no data, common practice is to revert back to a benchmark pattern which may not be appropriate for the book being analyzed.

2. The data is homogenous in each cell. This assumption is difficult in that the underlying warranties analyzed may change over time. For example, if the average new car warranty on cars sold five years ago was 36 months but it has now increased to 48 months, the historical pure premium at 60 months will not be predictive of the projected pure premium. In addition, the mix of business may change (European makes typically have higher costs than Asian makes, for example). Another problem is that the coverage offered typically changes due to market conditions.

- Mileage Driven – This is the exposure base proposed in this paper. If mileage is hypothesized as an exposure base, then there is an assumption that claims are basically a function of the number of miles driven by the vehicle. This method is helpful for a number of reasons:

    1. Underlying warranty information is typically available at the individual contract level. Therefore, one could explicitly model the miles driven inside and outside the manufacturer's warranty.
    2. Historical claims information at the end of the contract is not necessary to make an estimate of future claims. Future claims can be modeled as a function of miles driven and the underlying cost per mile. While the claims cost per mile will increase with age, this assumption can also be modeled and tested.

3. A Different Approach

A better approach than loss development for estimating ultimate costs for either pricing or reserving is an exposure based modeling basis, where future losses are modeled for all contracts. This approach has been suggested for modeling other insurance liabilities, such as environmental and asbestos claims (Bouska, 1996). There are several advantages to modeling at the exposure level.

Unlike many insurance products, extended warranty is a high frequency/low severity coverage. It is common for most extended warranties to experience several claims during the life of the warranty. Because of the nature of extended warranty claims, loss data at specific evaluations is credible at relatively low levels, if credibility is defined by the number of claims reported.

The difficulty is estimating the exposure base. This paper proposes an exposure base consisting of the miles driven for the vehicle, so that each mile driven under the warranty is considered an exposure unit.

A miles based exposure base over the term of the contract is closely matched to the actual exposure of the vehicle, as claims can be considered a function of the miles driven during the contract.

One problem with using miles as an exposure base is that there will be some increase in claims per mile during the latter periods of the contract when the frequency of claims will rise due to the age and mileage of the vehicle. This problem can be alleviated by a trend factor, though for newer sets of contracts it will remain a source of uncertainty.

4. A Warranty Pure Premium For a New Vehicle Using a Mileage Function

T_{BASIC} = Maximum term of manufacturer basic (full) warranty in months
T_{PT} = Maximum term of manufacturer power train warranty in months

T_{START} = Age of Vehicle in months (since in service date) at start date of extended warranty
T_{BA_REM} = Remaining term of manufacturer basic (full) warranty in months at start date of extended warranty
= $\text{Max}(0, T_{BASIC} - T_{START})$
T_{PT_REM} = Remaining term of manufacturer power train warranty in months at start date of extended warranty
= $\text{Max}(0, T_{PT} - T_{START})$
T_{EXT} = Maximum term in Months of extended warranty at start date of extended warranty

M_{BASIC} = Maximum term of manufacturer basic (full) warranty in miles (actual odometer reading)
M_{PT} = Maximum term of manufacturer power train warranty in miles (actual odometer reading)

M_{START} = Actual odometer reading in miles at start date of extended warranty
M_{BA_REM} = Remaining miles of manufacturer basic (full) warranty at start date of extended warranty
= $\text{Max}(0, M_{BASIC} - M_{START})$
M_{PT_REM} = Remaining miles of manufacturer power train warranty at start date of extended warranty
= $\text{Max}(0, M_{PT} - M_{START})$
M_{EXT} = Maximum term of extended warranty in miles at start date of extended warranty

The following two formulas are based on the assumption that the miles driven for any particular vehicle is proportionate to time and that the number of miles driven per time period for each vehicle, A, is randomly distributed as a lognormal function.

A lognormal may be a reasonable approximation for the distribution of driving habits since it is positively skewed and one can model the "high mileage" drivers in the tail of the function.

m(t)	=	miles driven at time t in months
	=	At
t(m)	=	time in months at which m miles have been driven
	=	m/A
t_0	=	start of extended warranty
	=	0
t_1	=	time of true expiration of manufacturer basic (full) warranty, measured in months from start of extended warranty
	=	Min (T_{BA_REM}, t[M_{BA_REM}])
t_2	=	time of true expiration of manufacturer power train warranty, measured in months from start of extended warranty
	=	Min (T_{PT_REM}, t[M_{PT_REM}])
t_3	=	time of true expiration of extended warranty, measured in months from start of extended warranty
	=	Min (T_{EXT}, t[M_{EXT}])
$Cost_{BASIC}$	=	Extended Warranty cost per mile while manufacturer basic (full) warranty is in effect
$Cost_{PT}$	=	Extended Warranty cost per mile after manufacturer basic (full) warranty expires and while manufacturer power train warranty is in effect
$Cost_{EXT}$	=	Extended Warranty cost per mile after both manufacturer basic (full) and power train warranties have expired
m(t)	=	mileage driven during extended warranty
k(t)	=	trend of repair costs
p(t)	=	trend rate of probability of claims and size of the claims as the vehicle ages
Prem	=	Extended warranty pure premium (4.1)

$$= \int_0^{t_1} Cost_{BASIC} * m(t) * k(t) * p(t + T_{START}) * dt$$

$$+ \int_{t_1}^{t_2} Cost_{PT} * m(t) * k(t) * p(t + T_{START}) * dt$$

$$+ \int_{t_2}^{t_3} Cost_{EXT} * m(t) * k(t) * p(t + T_{START}) * dt$$

5. A Simple Example

In the example, we will use a new vehicle for an extended warranty. For a used vehicle, there is typically not an underlying warranty, so a similar analysis can be performed. A "Wrap Coverage" is often sold for vehicles with a long manufacturer's warranty and provides coverage in areas that the manufacturer's warranty excludes. This product can also be modeled using a similar technique.

Assume a contract is sold for a new vehicle for 6 years/72,000 miles for a vehicle with a 3 year/36,000 mile manufacturer's warranty. Assume that the inflation rate is 3% and claims will increase in proportion to the miles driven another 4%. In this example, the driver is assumed to drive 15,000 miles per year.

Warranty Example

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year	Cumulative Miles	Miles in Manufacturer's Warranty	Cumulative Exposed Miles	Incremental Miles	Trend	Mileage Factor	Adjusted Exposed Miles	Percent Exposure
1	15,000	15,000	0	0	1.000	1.000	-	0%
2	30,000	30,000	0	0	1.030	1.040	-	0%
3	45,000	36,000	9,000	9,000	1.061	1.082	10,332	23%
4	60,000	36,000	24,000	15,000	1.093	1.125	18,444	41%
5	75,000	36,000	36,000	12,000	1.126	1.170	15,809	35%
6	90,000	36,000	36,000	0	1.160	1.217	-	0%
							44,585	100%

Assumptions:

15,000	Miles per Year
72,000	Contract Miles
36,000	Miles for the Manufacturer's Warranty
3.0%	Trend Rate for Repair Costs
4.0%	Mileage Trend

Column 1 represents the cumulative miles driven during the contract.

Column 2 is the cumulative miles covered by the manufacturer.

Column 3 is Column 1 – Column 2, subject to the limitations of the contract. In this example the warranty covers the 36,000 miles between the odometer readings of 36,000 and 72,000.

Column 4 is the incremental miles in Column 3 for each year

Column 5 is an estimate of the increase in repair costs.

Column 6 is an estimate of the rate of increase in claims due to the increased wear-and-tear on the vehicle.

Column 7 is Column 4 x Column 5 x Column 6. This is the adjusted miles.

Column 8 is the percentage of Column 7.

So in this example, we could assume that the earnings pattern should be 23% in Year 3, 41% in Year 4, and 35% in Year 5. Nothing would earn in Year 6 due to contract expiring due to miles. Years 1 and 2 would also earn nothing due to the manufacturer's warranty.

Issues with the Simplified Example

The example above is too simplified to utilize for a couple of reasons.

1. The assumption that no claims occur during the manufacturer's warranty is probably erroneous. Most contracts contain minimal coverage during the warranty period. This can be modeled by assuming the percentage of ultimate claims paid during the manufacturer's warranty.
2. Knowledge of the specific driving habits of a contract holder is unknown. In this example, we have assumed that the driver's mileage exceeds the maximum covered by the warranty in Year 5. That may be true for average driver on the book, but one could expect some earnings in the 6^{th} y ear for drivers who are driving fewer miles than the average for the book.

The next section will more closely examine estimating the average miles driven under Vehicle Service Contracts.

6. Estimating Miles Driven from the Contracts [m(t)]

A mileage function can be estimated from the average miles driven and therefore the percentage of the premium that ought to be earned in each period. One can examine all contracts that had a claim or cancellation (or both) and look at the average miles driven per month as of the last recorded event. This data will typically be available since coverage must be confirmed at the time of a claim and cancellations are typically "pro-rata" as to the greater of miles or time.

Instead of estimating a probability distribution for the mileage driven as shown above, it may be more practical to use a discrete approximation.

For our purposes, we will split the insured vehicles into five equal groups based on average miles driven per year at the time of the claim or cancellation with the arithmetic average calculated for each group. Then factors are calculated for each contract group assuming that claims are proportional to covered miles driven (miles under the contract but not under manufacturer warranty) and that the vehicle for each contract was driven at the respective average yearly rates. The final factor applied is the average of these five factors.

The factors thus derived for a new book of business may overstate earnings because the average miles generally decline as the warranty runs to expiration. This declining pattern is due to two factors - early claims are much more prevalent on cars with the most miles driven per month and as the higher mileage cars use up coverage, the average naturally declines.

Therefore, one can triangulate the data and project to ultimate the average miles driven per year.

For a new book of business, there may not be data available. In this case, the actuary may simply assume a distribution of miles or obtain driving mileage data from an external source.

For this example, the averages for the book have been estimated at the mileage rates below:

Estimated Mileage of Warranties Divided Into 5 Equal Groupings

	Base Average	Minimum Yearly	Maximum Yearly
Group 1	8,400	-	10,200
Group 2	12,000	10,201	13,200
Group 3	14,400	13,201	16,200
Group 4	18,000	16,201	20,400
Group 5	22,800	20,401	

7. A Better Example

Now we will redo the initial example with two changes. First, we will assume that 3% of claims occur during the manufacturer's warranty. Second, we will utilize the "5 bucket" approximation noted above and calculate the exposures for each scenario.

The results are shown below:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	Adjusted Exposed Miles 8,400 per year	Adjusted Exposed Miles 12,000 per year	Adjusted Exposed Miles 14,400 per year	Adjusted Exposed Miles 18,000 per year	Adjusted Exposed Miles 22,800 per year	Exposure Average	Percent Exposure
1	252	360	432	540	684	454	1%
2	252	360	432	540	9,708	2,258	7%
3	252	360	7,200	17,460	22,116	9,478	28%
4	8,148	11,640	13,968	17,460	3,492	10,942	32%
5	8,148	11,640	13,968	-	-	6,751	20%
6	8,148	11,640	-	-	-	3,958	12%
Total	25,200	36,000	36,000	36,000	36,000	33,840	100.00%

8. Developing a Coverage Factor

The use of a "coverage factor" when calculating mileage can be a simplifying assumption. For example, one can calculate the mileage driven inside the manufacturer's warranty, inside the Power Train warranty, and outside the warranty. Claims can be aggregated by examining the mileage on the claim in relation to the underlying warranty.

Calculation of Coverage Factors
(Miles 000)

Warranty	Initial Covered Miles	Reported Losses	Cost per Mile	Coverage Adjustment	Adjusted Covered Miles
Manufacturers	174,831	349,662	0.002	0.071	12,413
Power Train	33,082	496,230	0.015	0.536	17,732

None	324,504	9,086,112	0.028	1.000	324,504

In this example, the cost per mile for each type of warranty is placed in ratio to the cost per mile for claims outside the manufacturer's warranty. Miles inside the warranty are then adjusted downward to reflect the substantially lower claims during this period. In this case the cost per mile during no manufacturer's warranty is 2.8 cents per mile (9,086,122/324,504,000).

9. Estimating the Trend [k(t), p(t)]

As noted above, there are two types of trend that impact the vehicle as the warranty ages:

The first type of trend [k(t)] is the general increase in repair costs. Information concerning repair costs can be estimated from industry repair information or by using the Consumer Price Index (CPI). While repair costs increase due to general inflation, it is important to realize that this trend has been tempered in the past by the increasing reliability of automobiles.

The second type of trend [p(t)] is the increase in costs due to the age of the vehicle. Theoretically, this would be offset by decreasing claims consciousness as the vehicle ages, i.e. a vehicle owner may be more accepting of minor issues as the car ages. In addition, the owner of the vehicle may not know the warranty is in effect. While the warranty can typically be transferred or cancelled for refund by a vehicle owner when the vehicle is sold, there may be some cases where this does not occur.

One could also estimate the two trends simultaneously, since the observed data will have trends due to both the inflationary [k(t)] and aging [p(t)] impact

Using this methodology, there is an assumption that all differences in loss costs between development periods are due to changing costs due to inflation and the aging of the vehicle. Therefore, one should be aware of any changes outside of these factors that would have a significant impact on the loss ratios. These would include:

- Changes in coverages. Administrators may change the coverages offered from time-to-time which can result in different expected loss costs.
- Changes in claims settlement practices. There appears to be significant leeway in how claims are settled. It is common that administrators place more resources in denying or reducing marginal claims when results are above the expected level.

Losses should now be segregated by the time since policy inception, and mileage calculated by the methodology above, also dividing the mileage into periods since policy inception and adjusting the mileage by the coverage levels above.

At this point, one can compare the cost per mile for various ages to calculate the underlying trend for both the aging of the vehicle and the underlying inflation rate. In the example below, used car experience will be used since it is easier to display and more credible at lower mileage levels.

Trend Estimation (Calculation of P(t), K(t))
(Miles 000)

Make	Term	Coverage	Covered Miles	*Miles During Policy Age Months* 0-12	12-24	24-36	36-48	Undriven Miles
European	36	Used	47,520	24,948	7,128	3,564		11,880
American	36	Used	69,863	32,696	12,575	5,030		19,562
Asian	36	Used	74,199	38,346	15,789	2,256		17,808
European	48	Used	38,475	17,006	5,233	2,616	1,308	12,312
American	48	Used	69,925	27,271	9,999	5,454	2,727	24,474
Asian	48	Used	54,667	16,531	6,298	2,624	787	28,427

Make	Term	Coverage	Overall Average Cost per Mile	Cost per Mile in Successive Time Periods 0-12	12-24	24-36	36-48
European	36	Used	0.0414	0.0403	0.0429	0.0458	
American	36	Used	0.0258	0.0250	0.0269	0.0285	
Asian	36	Used	0.0152	0.0149	0.0156	0.0175	
European	48	Used	0.0465	0.0446	0.0473	0.0519	0.0568
American	48	Used	0.0316	0.0304	0.0317	0.0347	0.0374
Asian	48	Used	0.0209	0.0202	0.0212	0.0234	0.0256

Change in Cost per Mile over Time

Make	Term	Coverage	12-24	24-36	36-48
European	36	Used	6.5%	6.8%	
American	36	Used	7.6%	5.9%	
Asian	36	Used	4.7%	12.2%	
European	48	Used	6.1%	9.7%	9.4%
American	48	Used	4.3%	9.5%	7.8%
Asian	48	Used	5.0%	10.4%	9.4%
	Weighted Avg*		5.7%	8.6%	8.5%

Selected Trend	5.7%	8.6%	8.5%

* Weighted by covered miles

Note in this example the trends for each year range from 5.7% to 8.6%. One must be careful to anticipate that the trend may increase in the outlying years. It might be advisable to simulate different trend levels, especially on the later years, to check the sensitivity of the loss estimate to the trend assumption.

The trend can either be modeled directly into the mileage function (by increasing the estimated miles in proportion to the selected trend) or by directly trending the results. The first method may be more practical when the selected trend varies significantly by product, term, or other variable.

10. Calculating the Future Claims Rate ($Cost_{BASIC,}$ $Cost_{PT\,,}$ $Cost_{EXT}$)

As noted above, future claims costs is a function of the expected mileage driven times the cost per mile. The historical cost per mile can be easily calculated by taking the reported claims divided by the historical estimated miles. For future claims, a claims rate should be calculated for each contract based on the characteristics for this contract. Important characteristics one should consider are:

- The type and term of the coverage
- The deductible of the coverage.
- The mileage of the vehicle when the contract was purchased. It is important to segregate contracts from "new" vehicles from "nearly new" vehicles (vehicles with perhaps 1,000 miles on them) because they are typically significant claims differences at this level.
- A general grouping of the vehicle type. Typical groupings are by vehicle national origin (American, European, and Asian) with a couple of sub groupings for each type to differentiate between high cost makes and low cost makes. Certain make groups exhibit different claims characteristics. For example, Asian makes tend to exhibit lower claims costs than North American makes, which in turn exhibit lower claims costs than European makes.
- Other differences that you can model with the available data. For example, some books may have different distribution sources. A common structure is a "Producer Owned Reinsurance Company" where the ultimate liability for covering the claim will be at the servicing dealer. Not surprisingly, these books can exhibit significantly lower clams costs than books with claims paid by a third-party.

In general the actuary should model all available variables and discard those with little relation to claims costs.

In modeling the claims costs, an iterative minimum bias approach is recommended since many variables with have significant correlations. Generalized linear modeling may also provide good results.

Once again, the high frequency/low severity nature of this line will tend to provide more credible relativities at lower loss levels than other property/casualty lines.

11. Cancellations

Future cancellations should also be considered when evaluating a book of business. In general, cancellations will result in a refund of premium equal to the lesser of the proportion of the miles remaining to total miles or time remaining to the total term of the warranty. No consideration of underlying manufacturer's warranty is usually given. For example, if the warranty holder with a 6 year/72,000 mile contract cancels after three years and 50,000 miles, the warranty holder will receive approximately 31% of the premium as a refund ((72000-50000)/72000). This is true even though the majority of the exposure of the warranty remains. In effect, the refund is stated as pro-rata to miles driven or time, but the impact is that of a short-rate cancellation. Therefore, it is generally advantageous for the underwriter of new vehicles for the warranty to be cancelled.

12. Case Reserves and IBNR

Case reserves may or may not be held by an administrator, and are generally not a significant liability compared to the unearned premium reserve. Amounts held for pure incurred but not reported claims are rare since most claims must be pre-approved by the administrator before work can commence. Since the date of loss is typically the date of approval from the administrator, this should eliminate unreported claims except for supplemental payments beyond the initial estimate to repair the vehicle.

If reported losses are used to analyze a book, it should not be necessary to include additional reserves in your estimate. If paid losses are used, the actuary can do a paid loss analysis for a development pattern and add this to observed cost per mile or extend the terms of the contracts by the average delay between claim report and claim payment date.

13. Building the Indicated Rates

Indicated rates should be trended by the inflationary measure [p(t)] from the average accident date on the book until the average accident date of the proposed rates. Assuming terms offered are similar, it is simpler to trend from the effective date of the contract until the effective date of the new rate change. The final indicated loss cost is defined by:

(Reported Losses + Future Claims) x Cost Trend/Number of Warranties

where Future Claims is the Adjusted Mileage (adjusted for trend and coverage factors x Future Claims Rate.

Depending on the situation, other expenses such as taxes, underwriting expense, profit and contingencies, administrator fees, dealer commission and retail markup must be considered. However, some of these items may be either a flat dollar amount or percentage.

14. Conclusion

The methodology proposed in this article is certainly more complex, but should estimate costs better than traditional methodology. Fortunately, the data required to do this type of analysis is typically available from a vehicle service contract database. The unique characteristics of the book (such as term, coverages, and underlying warranties) are explicitly modeled using such an approach.

Because of the high credibility of extended warranty losses, detailed analysis can be done with small and immature books. Indeed, this type of analysis is even more appropriate for such books since a traditional "triangle analysis" will not have enough data for a good estimate.

By explicitly modeling the exposures, the actuary is forced to consider the specific elements such as the trend rate which will have the most impact on the estimate.

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