Measuring and Modifying the Effect of Auto Rating Factors[1]

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Abstract

This paper discusses different approaches to measuring the influence of rating factors on consumers' premiums. Two methods are analyzed in detail: the "Single Omit" method, and the "Average Class" method. A method for modifying the influence of a rating factor is described. A computer simulation estimates the effect in the California private passenger auto insurance market of using the two weighting methodologies. Each method measures the impact of modifying insurers' rating plans so that the three most influential rating factors are: safety record, mileage, and driving experience. The results did not show large differences in the overall impact between the two weighting methods. About four percent of consumers will experience a premium *increase* of $100 or more for a six month bodily injury policy, and about four percent will receive a *reduction* in premium of $100 or more. Most consumers pay within $30 of their current premium. The main difference between the two weighting methods was in administrative

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costs. The Single Omit method would require substantial computational work to implement. The Average Class would require the consistent use of a set of rating factors by all insurers in the market.

Introduction

During the last twenty years there has been considerable discussion concerning the affordability and methods used to price of auto insurance. A good deal of this discussion has focused on the rating factors used to set premium levels. The way rating factors are developed and used is an essential feature of insurance. Rating factors reflect detailed answers to the question of whom should pay and how much. Rating factors can reflect both economic and social value concerns, and there are tradeoffs in any decision affecting a rating factor. A system of rating factors that creates maximum risk-assessment efficiency can conflict with the fairest distribution of risk (Abraham, 1986).

De Wit (1986) describes this conflict as a tension between equivalency and solidarity. The individual equivalence principle states that there should be equivalence between an individual's premium and the expectation of loss. The solidarity principle states: 1) where it is necessary, people are ready to help one another, 2) an individual should not have to bear a disproportionally heavy burden, and 3) an individual should not have to bear an unfair burden. Other researchers have described this conflict as a tension between promoting free competition, on one hand, and social needs of welfare on the other (Kibildis, 1992; Austin, 1983). However, some see competition based on the use of rating factors as more of an effort at risk avoidance or risk selection competition. This type of competition, they claim, has limited value in producing a public good. Furthermore, it may actually be harmful by " . . . deflect[ing] public attention and competitive pressure on insurance away from forms of competition that might achieve the ends for which competition is revered: reduced overhead, improved services, and innovative products of high quality" (Wortham, 1986, p 350).

The fact that conflicts concerning the use of rating factors exist does not necessarily imply that a resolution cannot be reached. However, they do encourage the prioritizing of the goals involved, and the development of a system to implement the goals (Abraham, 1986). The two primary ways that the insurance industry can deal with society's desire for a change in the application of auto rating factors are: 1) by mutual agreement to restrict their behavior, and 2) by legislation. Both approaches have potential problems. The mutual agreement approach is likely to run into antitrust difficulties. The legislative approach has the risk of being too restrictive (de Wit, 1986).

Secondary to the arguments regarding the use of rating factors, but hardly insignificant, are concerns regarding the consequences of restricting the use of certain factors. The gender rating factor is a good example of this. Probably no other factor has created as much controversy as gender. Wallace (1984, p 129) estimated the effect of removing gender as an auto rating factor in Michigan as:

1) an average increase for single women < age 25 of at most 21 percent;

2) an average decrease for single men < age 25 of at most 15 percent; and

3) an average increase for the general "adult" classification of approximately 4 percent.

Wallace could not determine the exact effect on premium because the data analyzed did not ". . . allow analysis of the accompanying premium effects of driving record surcharges, inflation, the elimination of marital status as a rating factor and changes in age-based rating factors."

In an analysis controlling for the effect of all other rating factors, Hunstad (1993b) estimated a more modest effect for simultaneously removing gender, marital status, and age (but keeping a factor for “years licensed” as a close proxy for age) for a large representative insurer operating in California. Average changes in bodily injury premiums were as follows:

1) an average decrease for single males < age 25 of 9 percent;

2) an average decrease for single females < age 25 of 3 percent;

3) an average increase for married males < age 25 of 11 percent;

4) an average increase for married females < age 25 of 11 percent; and

5) an average increase for those not < age 25 of 1 percent.

Market dislocation is a significant concern to the regulators responsible for implementing changes to the regulations governing the use of rating factors. Thus, discussion of the dislocation impact of a policy change must go hand-in-hand with the legal and social arguments.

Proposition 103

In 1988, California voters chose a legislative approach to control the way rating factors are used and enacted Proposition 103. Among other things, this proposition requires that auto insurance premiums be primarily determined by the safety record, mileage, and driving experience rating factors. However, there has never been any generally accepted procedure for measuring the *weight* or influence of a rating factor, and the proposition did not provide any.[3] The method used

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[3]It should be noted that there is controversy about exactly what the proposition requires. The proposition says that "... automobile rates shall be determined primarily by a driver's safety record and mileage driven." and "... premiums ... shall be determined by application of the following factors in

to measure weight is important because, depending on how regulations define it, the price of auto insurance for millions of consumers will be affected. The analysis presented in this paper estimates the impact of different approaches to measuring weight.

Measuring Weight

Hunstad and Bernstein (1993a) explored the issue of measuring a rating factor's weight, and a technical symposium was conducted by the California Department of Insurance in January 1994. The primary findings of this work were the identification of how weighting methodologies can differ, and the positive and negative characteristics of certain methods. The primary areas in which weighting methodologies differ are: 1) the point in the rating process where a factor is measured; 2) the type of measurement used; 3) the population measured; and 4) the types of coverage on which the weights are assessed. Positive features of a weighting methodology were: 1) reflecting the full impact of the factor; 2) handling extreme values the same as mid-range values[4]; 3) permitting comparison of different types of factors; 4) reflecting how the factor

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decreasing order of importance ...". One point of view is that as long as rating factors are analyzed in the order specified by the proposition, with each subsequent factor having the influence of all prior factors removed prior to the development of its rates, then the requirements of the proposition are met. This point of view holds that it does not matter how much the factor causes consumers' premiums to change. An alternate view says that it is precisely this change in consumers' premiums that must be captured in any measurement of a rating factor's influence on premium. While this is an issue that will most likely be ultimately settled in the courts, this paper takes the point of view that the measurement of the influence of a rating factor must take into account how the rating factor causes consumers' premiums to vary. The purpose of this paper in not to argue for or against any particular interpretation of the language contained in Proposition 103. The intent here is to explore and analyze methods to measure how rating factors effect consumers’ premiums. Additionally, we show a method for modifying the influence of specific rating factors and the impact these modifications have on consumers’ premiums.

[4]There was some discussion concerning the desirability of a weighting methodology treating all impacts of a rating factor in an equal manner. This principal states that it is desirable for each dollar change caused by the use of a rating factor to be treated equally in assessing the overall influence of the rating factor. A counter position states that the measurement of the overall influence of a rating factor

causes variations in premium among its categories; and 5) not requiring a specific population to evaluate the factor's weight. Negative features of a weighting methodology were: 1) not reflecting the full influence the factor has on the final premium; 2) extra sensitivity to extreme values; 3) not reflecting how the factor causes premiums to vary among its categories; 4) ignoring extreme values completely; 5) having an arbitrary component in the measurement process that influences the results; and 6) not working well or providing misleading information for certain types of rating factors.

Previous work of the author considered several approaches to measuring weight. These approached and their problems included:

Weighting Method	Description	Problems
Maximum Absolute Influence	The difference between the highest and lowest relativities of the factor.	This method only uses extreme values and does not reflect group variation.
Median Influence	The median value for the factor's influence, (as measured by the Single Omit method).	This method ignores extreme values and does not reflect group variation.

should not treat all changes the same. Any method that squares the difference from a mean is an example of a method that gives increased influence to individual measurements that are farther away from the mean. A modification to the Single Omit method (described later) that uses *percentage* difference instead of *dollar* difference, is an example of a method that gives decreased influence to individuals with large premiums. In the absence of a strong mandate to treat certain individuals differently, we believe it desirable to treat each dollar difference caused by a rating factor the same, regardless of the characteristics of the particular individual effected.

Middle Range	The middle range (consisting of 50 percent, 60 percent, 70 percent, 80 percent, or 90 percent of the population) of the factor's influence, (as measured by the Single Omit method).	This method ignores extreme values. There is no clear rationale for choosing a specific middle range, and the chosen range influences the results.
ANOVA	The significance level (or alternately, the F-ratio) of the factor and the premium level.	This method has technical problems with factors that have many categories. Increased importance is given to extreme cases.
Correlation	The Pearson correlation coefficient of the factor and the premium level.	This method has technical problems with certain kinds of factors. Increased importance is given to extreme cases.
Multiple Regression	The beta weights from the regression equation with premium as the dependent variable and all other factors as independent variables.	Increased importance is given to extreme cases. Possible technical problems with certain combinations of data and factors.

The two approaches with the most potential were the "Single Omit" method and the "Average Class" method. The Single Omit method calculates the weight of a rating factor by examining the effect on premium if the factor were omitted from the premium calculation algorithm. It is a three step process. The first step involves computing the premium for the coverage that is being analyzed using the complete algorithm with all rating factors. In the second step, the factor being analyzed is removed from the algorithm and the premium is recomputed without the factor. In the third step the premium calculated in the first step is subtracted from the premium calculated in the second step. If the number calculated in the third step is negative, it is converted to a positive number. These three steps are repeated for each vehicle insured by the company. Finally, the average of all the differences computed in the third step is calculated. This average is the weight of the rating factor for the coverage being analyzed.

The Average Class method calculates a rating factor's weight by averaging the differences between the relativities of each category used by the rating factor. The first step is to compute the difference between each relativity and the relativity next to it. The second and final step is to compute the average of those differences. This average is the weight of the rating factor for the coverage being analyzed.

Note that while both methods produce a measurement of weight, the scale used by each method is different. A weight computed by the Single Omit method cannot be compared with a weight prepared by the Average Class method and vice versa. Only rating factor weights computed by the same method can be compared with each other. In both methods, larger weights imply greater influence on premium.

To illustrate how both methods would be used in computing a rating factor's weight, consider the mileage rating factor and a hypothetical insurer with 1,000,000 insured vehicles. The mileage categories are: 1) 0 to 5,000; 2) 5,001 to 8,000; 3) 8,001 to 12,000; 4) 12,001 to 15,000; and 5) 15,001 or more. The multiplicative relativities are: 1) 0.50; 2) 0.75; 3) 1.00; 4) 1.20; and 5) 1.60, respectively.

Single Omit Weight for the Mileage Factor

Step	Description		Results
1	For the first vehicle insured by the company, calculate the premium using the company's complete algorithm.	$58.50	
2	Remove the mileage rating factor from the algorithm and recalculate the premium. *(This vehicle was driven 7,000 miles per year and had received a 25 percent discount).*	$78.00	
3	Subtract the premium calculated in Step #1 from the premium calculated in Step #2, if a negative number is obtained, take the absolute value.	$19.50	
4	Repeat Step #1 for the second vehicle insured by the company.		$641.25
5	Repeat Step #2 for the second vehicle insured by the company. *(This vehicle was driven 14,000 miles per year and had received a 20 percent surcharge).*		$534.38
6	Repeat Step #3 for the second vehicle insured by the company.		$106.87
. . .	Repeat steps #1, #2, and #3 for the remaining 999,998 vehicles.		
3,000,001	Calculate the average of the amounts calculated in step #3 for all vehicles. THIS IS THE FACTOR'S WEIGHT.	63.185	

Average Class Weight for the Mileage Factor

Step	Description	Results
1	Compute the difference between each mileage category.	0.75 - 0.50 = 0.25 1.00 - 0.75 = 0.25 1.20 - 1.00 = 0.20 1.60 - 1.20 = 0.40

2	Calculate the average of the differences from Step #1. THIS IS THE FACTOR'S WEIGHT.	1.10 / 4 = 0.275

Key differences between these two methods are:

- the Single Omit method weight reflects the average of *all* the individual insureds, and is influenced by the distribution of the population being measured;
- the Single Omit method requires extensive calculation;
- the Average Class method weight requires minimal calculation;
- the Average Class method does not require detailed data on every insured vehicle and driver;
- the Average Class method *may* not reflect the average of *all* the individual experiences, and is not influenced by the distribution of the population being measured; and
- to be effectively used, the Average Class method requires the use of standardized rating factors, or some restrictions on the categories used by the rating factors.

The fact that the Average Class method may not reflect the average of all the individual experiences illustrates a significant difference in what each method measures. A key determinant of how closely the Average Class method weights represent the average of all individual experiences is how the rating factors and their categories are defined. If each company were free to adjust the definition and categories of the rating factors, it could minimize the factor's influence on premium while maximizing the factor's weight. In other words, a company could manipulate the categories so that it could get a high weight without a corresponding high influence on premium. An example of this type of manipulation would be where a company uses only two mileage categories, and one of the mileage categories applies to a very small portion of the company's consumers. To avoid such situations, it is necessary to either place restrictions on the way categories are created and used, or to use standardized rating factors consistently by all insurers.

Standardized Rating Factors

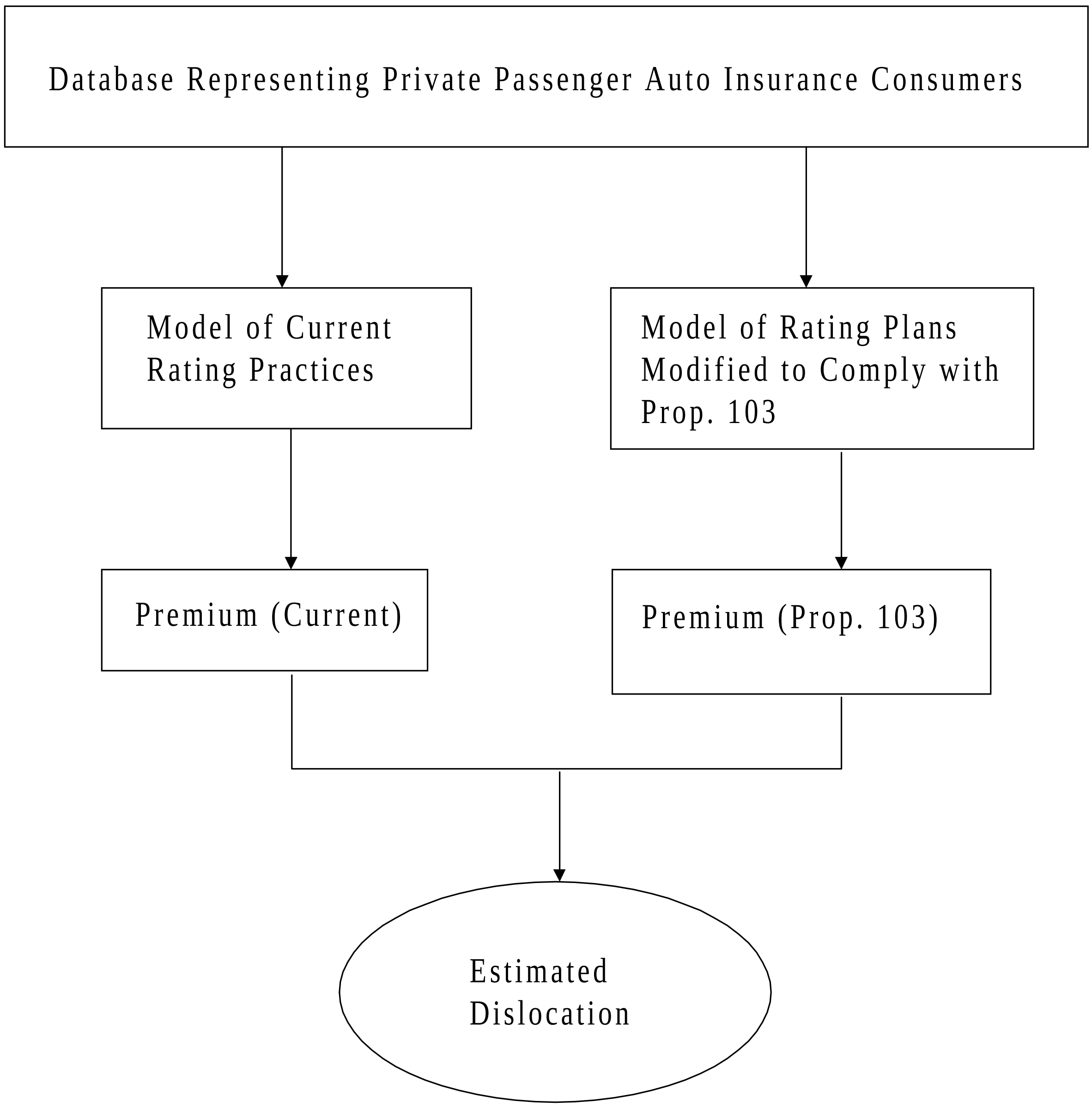
Standardized factors may have other benefits besides easing the measurement of weight using the Average Class method. One commentator has described the auto insurance market as a world "where confusion reigns and where the best deals aren't the most obvious ones . . . " (Reisman, 1994, p 99). By clearly identifying the arena where competition is to occur, competition will be increased and the appearance of "arbitrary insurance rates and practices" will be reduced. To the extent that competition focuses on price, consumers are likely to see an overall lowering of auto insurance premiums. However, this is clearly a controversial area. Other researchers have suggested standards for developing rating factors and have encouraged the development of shopping guides and standards for policy readability, suggesting that this would facilitate consumers' ability to compare and ". . . stimulate competition in price and services" (Wortham, 1986, p 350). This view is not universal. Casey (1976, p 130) says the limiting of how insurers develop and implement rating factors could lead to ". . . market dislocations, subsidies among consumers and availability problems for some groups of consumers." Harrington (1993, p 59) estimates that the direct efficiency lost due to limitations on insurers use of rating factors would be small, ". . . but the indirect effects of restrictions will probably be to increase the cost of risk by distorting incentives for claim settlement and for legislative actions to control claim costs."

Analysis Procedures

The analytic approach used to estimate the impact of the different weighting alternates uses a technique called "microsimulation" modeling. Unlike analytic methods that manipulate aggregate summaries of data or use ratios, (all of which tend to reduce the variability included in the analysis), the microsimulation approach relies on data at the individual level. The basic approached is illustrated in Figure 1, and consists of:

- creating a representative database (in this case, insurance consumers in California);
- creating a model of current rating practices;
- creating a model of rating practices that have had the weights measured for all rating factors and each rating factor has been modified (if necessary) to meet the weighting requirements of premium being primarily determined by safety record, mileage, and years licensed; and
- comparing the differences between current practices and the new model.

Figure 1.
Microsimulation Model for Estimating the Dislocation of Modifying Current Rating Practices to Make Safety Record, Mileage, and Driving Experience the Three Most Influential Rating Factors



Creating a Database to Represent California Consumers

The data needed to build the database from which the modeling would be performed was acquired by the California Department of Insurance. The Department issued special data call to the top eleven auto insurer groups in the state plus one major writer of substandard auto policies. Detailed rating information *for each individual consumer* from each of the twelve insurer groups was acquired. A policy record was built that contained all of the basic demographic, safety, mileage, and other factors that the insurers used to calculate the premiums. In total, the twelve insurer groups had about eleven million customers (roughly 80 percent of the private passenger auto market in California). Because of concerns about confidentiality and trade secrets, the data were collected under the authority of a section in the insurance code that allows the Commissioner to keep the data confidential. Thus, the names of the insurance companies, as well as the results by company, have not been included in this paper.

Modeling Current Practices

After the Department created the database, it developed computer programs that replicated each insurer's current rating algorithm. All the rating factors as currently used by each company, and a complete listing of their corresponding relativities were programmed into the model. Once this was completed, the premium was computed and compared with the premium the company reported that it charged the consumer. If any discrepancies were discovered, the company was contacted and differences resolved.

To model the impact on the entire market, the impact on each individual insurer had to be estimated. To do this, a separate submodel was prepared for each insurance company. Once dislocation impacts were calculated for the customers of a particular insurance company, the results were aggregated across all companies to reflect the market as a whole. Because of the extensive amount of work required to duplicate each insurer's current rating practices, the

Department decided that the primary analysis would be limited to one coverage. As bodily injury liability is the largest component of total auto insurance costs and premium, it was selected as the coverage to analyze. One large company was selected for an analysis of all coverages. The results for this "all coverages analysis" are shown elsewhere (Hunstad, 1994).

A criterion of at least 98 percent replication of current premium was established before data was accepted as "clean." For almost all insurers, it was possible to replicate premium calculations at a level above 99 percent. However, only nine of the twelve companies passed this standard. Two other companies submitted corrected data too late to be included in the analysis. One company failed to timely provide sufficient documentation of its practices. Excluding these three insurers left the database with approximately nine million consumers for the microsimulation.

Modeling Conversion to Standardized Factors

To develop the models that used standardized factors, it was necessary to transform each company's current rating practices into a rating plan utilizing standardized factors.[5] This involved estimating the relativities the company would use for each of the new standardized rating factors. Ideally it would have been desirable to base these estimates on an analysis of several years of loss

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[5]In total sixteen standardized factors were used in the analysis. They included: Safety Record, Mileage, Years Licensed, Claims Frequency, Claims Severity, Vehicle Type/Performance, Vehicle Use, Percentage Use by Rated Driver, Multi-car Discount, Academic Standing, Senior Defensive Driver Discount, Vehicle Safety Equipment, Good Driver Discount, Gender, Persistency, and Non-Smoker Discount. These sixteen factors were selected after compiling all the rating factors used by the top eleven insurers in California. Prior to finalizing the rating factor definitions, they were subjected to two reviews. The first review was by a Department of Insurance committee composed of rate analysts, actuaries, and attorneys; the second review was preformed by an consulting actuary. See Hunstad (1994) for a detailed listing of the factor categories.

data specific to each company. The Department requested loss data as part of the data call mentioned above. However, the quantity and quality of the data and the categories used to classify the losses were such that they could not be used to develop new relativities for new categories. A common problem was that most companies were unable to link their loss data with their classification data, except in the most limited way. Consequently, each company's current relativities were used to estimate the relativities for the new standardized factors. Department analysts assumed that companies' current relativities were based on an analysis of loss data and generally reflected the underlying distribution of loss costs. The use of current relativities was the best alternative to analyzing the detailed loss data that most companies could not provide.

The procedure used to estimate the new relativities was interpolation. When the categories of the new standardized factors did not perfectly match the current practices of the company, the two closest relativities currently in use by the company were used to estimate the relativity for the new category. For example, if a company had relativities for 10,000 miles and 15,000 miles and a relativity for 12,500 miles needed to be estimated, the midpoint of the two known relativities was selected. Without additional data on loss experience, the interpolation procedure is a good way of estimating the relativity for the new category. It is not biased by being consistently high or low. We considered an alternate procedure that involved first fitting a distribution function to the relativities and then using the fitted distribution to estimate the new relativity. However, it was decided that the increase in accuracy would be marginal given the time and effort needed to implement the approach for every factor for every insurer included in the analysis. The Department realized that if the individual insurers were to implement the standardized categories, they would generally have access to much more detailed data. Also, they could invest a much greater amount of time and effort in developing the new relativities. This would make it possible for them to develop new relativities that fit their data (and customers) much more closely. Consequently, it is probable that if companies implement the standardized factors, they will create rating plans that generate less dislocation than has been estimated in this analysis.

The next step in developing these models involved determining the appropriate category for each standardized factor for each individual vehicle/driver combination. When the categories currently used by the company matched the standardized categories, this involved a simple transfer from the old category to the new. When the categories did not match, the raw data were evaluated to place the policy in the correct standardized category. There were a small number of companies that did not have matching categories for some factors nor did they have the raw data in sufficient detail to precisely place the policy. In these situations, the information that was available was used to identify the most appropriate two or three standardized categories. Next, analysts determined the percentage of cases in the overall market that fell in each of the most appropriate two or three categories. Finally a random assignment process was conducted to place a specific policy in a specific standardized category in a way that produced a distribution that was the same as the market as a whole. For example, a company with two mileage categories, under 7,500 and over 7,500, had to have its policies allocated into the nine categories used in the simulation. If the raw (ungrouped) data were available, they were used to place each policy in the most appropriate category. If the raw data were not available, then those policies currently classified as under 7,500 miles were randomly assigned to the three standardized categories under 7,500. This assignment process was such that the resulting distribution of cases under 7,500 miles was assigned to the three lowest standardized categories in a way that matched the market wide distribution of cases with mileage under 7,500 miles.

These assignments resulted in some persons who were assigned to lower mileage categories appearing to warrant lower premiums, while some who were assigned to upper mileage categories appearing to warrant higher premiums. The distribution as a whole is neutral. Depending on the range of difference between the (unknown) actual and the assigned mileage category, this procedure could introduce some bias in terms of predicting the direction and magnitude of dislocation for a specific individual with given characteristics, although the overall company wide results are accurate. Should a company use the standardized mileage categories that are reflected in the simulation, the overall distribution would be accurate. However, the individual increases and decreases would not be as accurate as the overall distribution. Thus, different rating formulae, different factors, and different ways of defining rating factors were simulated for each insurance company. The dislocation, the difference between current premium and newly calculated premium, was used to evaluate the consequences.

Pumping and Tempering

To determine the impact of modifying rating plans so that the premium was primarily determined by the safety record, mileage, and years licensed rating factors, initial weights were computed for all the rating factors. These initial weights were computed using each weighting method. As none of the companies had the weights for safety record, mileage, and years licensed in the required order, it was necessary to “pump” or “temper” some factors to achieve the correct ordering[6]. Pumping refers to increasing the weight of a factor, while tempering is the decreasing of a factor's weight.

The procedure for pumping and tempering was as follows:

1) Compute a weighted average of the current relativities for the factor. The relativities were weighted by the percent of the company's policies that fell in each category. The weighted average would be 1.0 if the rating factor was a multiplicative factor and was revenue neutral.

2) Subtract either the weighted average relativity or the neutral factor (e.g., 1.0) from each category's relativity.

3) Multiply the value in the second step by the weighting factor constant.

4) Add the amount back to the weighted average or 1.0.

Weighting factor constants less than 1.00 results in tempering (or decreasing the effect of the factor), while weighting factor constants greater than 1.00 results in pumping (or increasing the effect of the factor). The procedure for modifying factors can be expressed by the following formula:

$$NR = ((IR - WA) * C) + WA,$$

[6]Some observers believe that it is against actuarial principals to pump or temper the relativities of a rating factor. However, these same observers do not object to the fairly common practice of modifying relativities for marketing purposes. Their position is that pumping or tempering creates unfair discrimination because the modified rating factor creates rates that are excessive for some and inadequate for others.

Other observers maintain that unfair discrimination is not automatically created when relativities deviate from loss costs. They believe that rates should follow loss costs except when another provision of law applies. Public policy concerns expressed in a law is a other provision that would take precedence over loss costs. As actuarial principals acknowledge that “risk classification may be affected by constitutions (state and federal), statutes, and regulations” (Casuality Actuarial Society, 1990, p 242) such a deviation does not appear to be against actuarial principals.

where: NR = New Relativity (after pumping/tempering)

IR = Initial Relativity (before pumping/tempering)

WA = Weighted Average or the 1.0 neutral factor

C = the Pumping/Tempering Constant

Once a factor whose weight is either too high or too low is pumped or tempered, its weight is re-computed. If the resulting factor weights are in the correct order, the modifications to the factor are complete. Once all the weights for all the factors are ordered as required, the company is in compliance. Next, the base rate is adjusted (if necessary) to obtain overall revenue neutrality. The final step involves computing a new premium with the pumped/tempered rating factors and comparing it with the premium that the consumer is currently paying.

Modeling Compliance With Proposition 103 via Single Omit

The Department analyzed two models of the Single Omit method. One model was based on the standardized factors. The second model was based primarily on the company-defined factors. The models with company-defined rating factors were limited to rating factors that were allowable according to the latest auto rating factor regulations proposed by the Department (commonly known as the "RH318" regulations). This primarily involved removing the marital status factor and transferring the rates reflected in the age factor to the years licensed factor. Due to time and funding constraints, it was only possible to include five companies in the Single Omit model without standardized factors. In the model with the *company-defined* factors, it was necessary to use the *standardized* factors for mileage and/or years licensed for some companies with only a few categories per factor. If the model did not include these changes, the resulting pumping and dislocation would have been larger. Also, in the model with company defined factors, the single territory factor that insurers currently use was divided into two factors: frequency and severity. This also helped to minimize pumping and to keep dislocation low. Since insurers could make all of the above described changes to their rating plans, these procedures arguably did not understate dislocation. If anything, dislocation could be somewhat overstated as insurers would have more time and resources available to fine tune these procedures to minimize dislocation.

The rating plans were modified so that the three primary influences on premium were safety record, mileage, and years licensed. To do so, it was necessary to modify the mileage factor, more than any other factor. To achieve compliance for the mileage factor, it was necessary to increase its weight from 173 percent to 2,123 percent. This need to substantially alter the influence of annual mileage will be a major source of dislocation. After the mileage factor, the years licensed factor had the most deviation from compliance. Both versions of the Single Omit model used only pumping to achieve compliance. Using a combination of pumping and tempering would probably have reduced dislocation. Also, the pumping needed and the factors affected varied by the version of the Single Omit method that was being modeled.

Modeling Compliance With Proposition 103 via Average Class

As with the procedure for the Single Omit method, the first step in modeling the Average Class method involved calculating initial weights for all factors. Once initial weights were calculated using the Average Class method, those factors that were not in the order required were either pumped or tempered until the required order was obtained. No attempt was made to fine tune or minimize the pumping and tempering of the factors. An initial estimate was made as to the most effective way to achieve the proper weights. After several iterations the model reached compliance. No additional attempts were made to create the model that minimized dislocations. Specific insurers with more time to analyze their data may be able to modify their rating plans to achieve the required ordering of rating factors with less dislocation. Once all the factors were properly ordered, the new premium was calculated and compared with the premium that the consumer is currently paying.

The Average Class model used both pumping and tempering to achieve compliance. While the Single Omit models only pumped the three mandatory factors, the Average Class method sometimes tempered one or more of the optional rating factors. The amounts of pumping applied by both the Single Omit model using the standardized factors and the Average Class model that also used the standardized factors were roughly similar. This indicates that the factors were roughly at the same level out of compliance despite the method used to measure compliance. It also illustrates two different approaches to achieving compliance: pump only, and pump and temper. (The initial and final weights, as well as the percent change in weight shown by factor by company is included in Hunstad, 1994.)

Classifying Dislocation

When the new premium computed by a model differs from the premium currently paid by the consumer, dislocation or a change in the amount paid by the consumer has occurred. The change in premium can be either an increase in the amount paid or a decrease. While nobody likes to pay more, to change current practices without an overall lowering of rates, some individuals must pay more and some individuals must pay less.

One objective of Proposition 103 was to make safety record, mileage, and years licensed the three most important rating factors in determining how much consumers pay for auto insurance. To this end the Proposition holds that *safe* drivers should pay less than *unsafe* drivers, people who *drive more* should pay more than people who *drive less*, and *experienced* drivers should pay less than *inexperienced* drivers. To estimate if these objectives were achieved, dislocation or premium changes were divided into two basic types: intended or positive dislocation, and unintended or negative dislocation.

Intended or positive dislocation occurs when: 1) good drivers pay less, 2) low mileage drivers pay less, 3) experienced drivers pay less, 4) poor drivers pay more, 5) high mileage drivers pay more, and 6) inexperienced drivers pay more. Similarly unintended or negative dislocation occurs when: 1) good drivers pay more, 2) low mileage drivers pay more, 3) experienced drivers pay more, 4) poor drivers pay less, 5) high mileage drivers pay less, and 6) inexperienced drivers pay less.

To quantify these concepts, we identified different risk levels and refined the categorizations of dislocation into four categories. The different risk levels were:

1) Higher Risks: Either not a good driver, a high mileage vehicle, *or* not an experienced driver;
2) Lower Risks: Either a good driver, a low mileage vehicle, *or* an experienced driver;
3) Pure High Risks: Not a good driver, a high mileage vehicle, *and* not an experienced driver;
4) Pure Low Risks: A good driver, a low mileage vehicle, *and* an experienced driver.

The dislocation categories were defined by the following ordered procedure:[7]

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[7]It should be noted that this assignment procedure has a positive bias. In effect, it looks for a reason to justify the direction of the change in premium. If it finds a reason that is consistent with Proposition 103, then the dislocation is considered positive. If there is no reason to justify the direction of the premium change, then the dislocation is classified as "other" or "negative". For example, if a particular

1) Nil: A premium change within +/- 10 percent of current premium.
2) Positive: a) A premium increase for higher or pure high risks, or
b) A premium decrease for lower or pure low risks.
3) Other: a) A premium increase for a lower risk who is not a pure low risk, or
b) A premium decrease for a high risk who is not a pure high risk.
4) Negative: a) A premium increase for a pure low risk, or
b) A premium decrease for a pure high risk.

Findings

Average Dislocations

One constraint placed on each model was that it must be revenue neutral. In other words, the total premiums collected by each company must remain the same. The results of this revenue neutral requirement are that the average change in premium for each company will always be zero. However, when one examines particular subgroups of consumers, different policy options show different impacts. Table 1 summarizes the average dislocation experienced by selected consumer groupings for six month premiums of bodily injury coverage.

The first thing to note about the average dislocation results is that they represent the *average* experiences of the individuals in each group. Some individuals in the group will have much higher premiums changes, and some individuals in the group will have much lower premium changes. For most consumer groups, there is not that much change in the average premium. Most of the larger average changes occur at the extreme ends of the mileage groups

driver could be considered both a higher risk and a lower risk (e.g., by being both inexperienced and low mileage) their dislocation would always be classified as positive if it was greater than 10 percent. As the primary purpose for classifying the type of dislocation was to differentiate between the two weighting methods, the fact that a bias exists was not considered to be a significant problem because the procedure was equally applied to each method, and the difference between the methods was the key concern. Initially, it was planned to develop a dislocation classification procedure that had an equal negative bias, but resources and funding limitations prevented including this second dislocation classification procedure in the analysis.

(affecting the very low mileage drivers and the very high mileage drivers) and among the very young or inexperienced drivers. These changes seem consistent with the intent of Proposition 103.

The average result of complying with Proposition 103 by either weighting method using the standardized factors is fairly constant throughout all the different geographic areas in the state. In Los Angeles County average reductions in premiums were $7 to $8. In Sacramento and Fresno Counties average increases were $13 to $14. In the San Francisco Bay Area average increases were around $4. These small changes by area were, at least partially, the result of the method used for handling the influence of territory on premiums. In this analysis, territory's influence was divided into the two rating factors Frequency and Severity. Hunstad (1994) provides a detailed explanation of how these two factors were developed, estimates the impact of this single change, and estimates the impacts of two alternate approaches.

The main difference between the Average Class and the Single Omit methods using the standardized factors seems to be in the dislocations associated with the mileage and the driving experience groups. The Average Class method increases the spread in average premium levels between the low mileage category and the high mileage category when compared with the Single Omit method. The lowest mileage category (0 to 3,000 miles) sees an average reduction of $41 with the Average Class method and an average reduction of $17 with the Single Omit with standardized factors method. The highest mileage category (over 15,000 miles) sees an average increase of $56 with the Average Class method and an average increase of $30 with the Single Omit with standardized factors method. There is even less difference when the Average Class method is compared with the Single Omit method without the standardized factors.

Just the opposite occurs with the driving experience groups. The Single Omit with standardized factors method increases the spread in average premium level between the inexperienced driver category and the highly experienced driver category. The least experienced drivers (0 to 2 years licensed) see an average increase of $94 with the Single Omit with standardized factors method and an average increase of $2 with the Average Class method. The Single Omit method without standardized factors does not produce as wide a spread in average dislocation as does the Single Omit with standardized factors method.

Table 1.

Average Dislocations for Semi-Annual Bodily Injury Coverage
for Different Weighting Methods

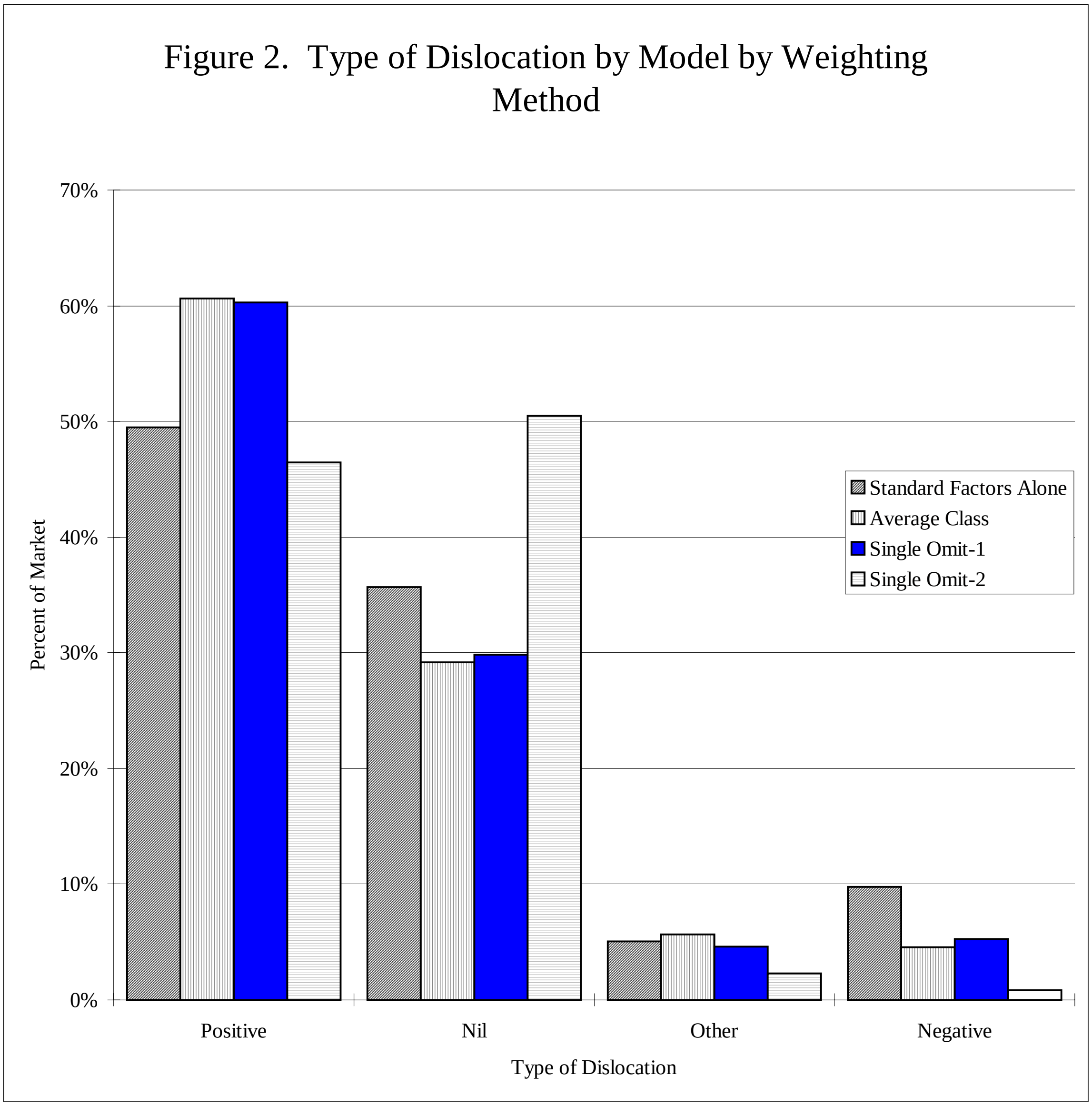
Group	% of Insureds	Standard Factors Only	Average Class	Single Omit-1	Single Omit-2
Total	100%	$0	$0	$0	$0
"Good Driver"					
No	8%	($7)	($6)	$17	$10
Yes	92%	$1	$1	($1)	($1)
Annual Mileage:					
0 to 3,000	10%	$4	($41)	($17)	($42)
3,001 to 5,000	14%	$6	($18)	($6)	($30)
5,001 to 8,000	22%	($0)	($5)	($4)	($15)
8,001 to 10,000	28%	($3)	$3	$0	$14
10,001 to 12,000	12%	($3)	$17	$7	$18
12,001 to 15,000	8%	($1)	$30	$14	$21
over 15,000	5%	$2	$56	$30	$25
Driving Experience:					
0 to 2years	2%	$26	$2	$94	$33
3 to 13 years	19%	$15	$23	$31	$11
14 to 48 years	68%	($7)	($6)	($13)	($2)
49 or more	11%	$11	($4)	$3	($10)
Area:					
S. Calif.					
L.A. only	23%	($5)	($7)	($8)	($2)
Costal Counties	22%	$0	$1	$2	$1
Inland Counties	8%	($2)	($0)	($0)	$2
Rest of Calif.:					
S.F. Bay Area	24%	$3	$4	$4	($0)
Sacto. & Fresno Cos.	6%	$13	$14	$13	$2
Rural N. & Valley	16%	($1)	($1)	($0)	$1

Note: The "Standard Factors Only" model does not modify (i.e., pump or temper) any rating factor. Hense, the rating factors are not in the order required by Proposition 103. This model only shows the effect of converting from rating systems that are different for each insurer to a standard rating system use by all insurers.
"Average Class" uses standardized factors.
"Single Omit-1" uses standardized factors.
"Single Omit-2" uses mostly allowable rating factors as currently defined.
These results are based on simulations involving approximately 9 million consumer records.

Overall, drivers with or without the Good Driver Discount do not see much change in average premium. The most likely explanation for this is because almost none of the insurance companies had to have the safety record factor modified in either weighting method. This suggests that most insurers are currently giving an individual's safety record a large role in setting the premium level. As neither weighting method called for much of a change in how the safety record factor was being used, one possible explanation for those drivers not qualifying for the Good Driver Discount averaging a $6 reduction in premium with the Average Class method, while seeing an average increase of $17 with the Single Omit with standardized factors method, is that many of these drivers are in the lower mileage categories. Thus, they get a larger reduction in premium under the Average Class method than they receive with the Single Omit method. Also, several years ago when an emergency version (ER-10A) of Proposition 103 regulations was implemented, good drivers started receiving a 20 percent discount. This discount was included in the weight calculated for the safety record factor under the Single Omit methods and is one reason that it was not necessary to modify the safety record factor.

Type of Dislocation

Figure 2 shows the type of dislocation associated with each model. In general there is not much difference between any of the four models. For the Single Omit with standardized factors and the Average Class models, about 60 percent of the population experience positive dislocation, 30 percent keep a premium that is within +/- 10 percent of their current premium, 5 percent are classified as other dislocation, and 5 percent experience negative dislocation. The largest incidence of negative dislocation occurs with the Standardized Factors alone model. This model implements the standardized factors, but does not comply with the requirement that safety record, mileage, and years licensed be the primary influence on premium, so it is not too surprising that there is not more positive dislocation. It is included in this analysis primarily to show the incremental costs of compliance with the weighting requirements after standardized factors are introduced. By itself, standardized factors do not comply with the weighting requirements and, is not a policy option. The least amount of negative dislocation and the most "nil" dislocation occurs with the Single Omit model without the standardized factors. This is not too surprising because this model is the closest to companies' current practices. Although in some instances the companies' current practices were modified to make it easier to get safety record, mileage, and years licensed to be the three most influential rating factors.

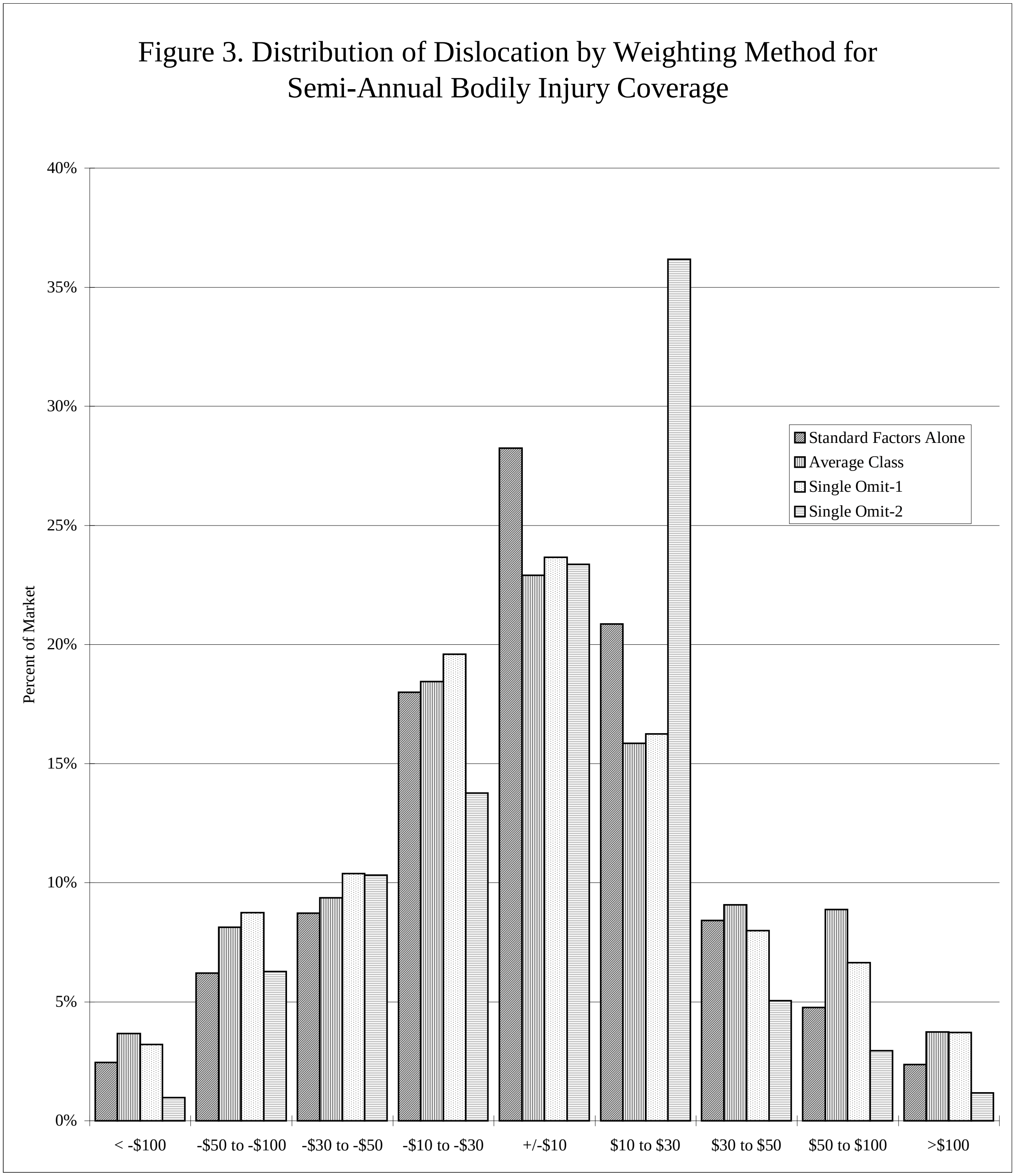


Note:
"Single Omit-1" uses the Single Omit weighting method to measure the influence of the standard rating factors.
"Single Omit-2" uses the Single Omit weighting method to measure the influence of a set of ratng factors that are primarily the ones currently used by the nine insurers included in this analysis.
"Nil" dislocation is a new (modeled) premium within +/- 10% of current premium.
"Positive" dislcoation is a premium change of > 10% among higher risk drivers or a premium. change of < 10% among lower risk drivers.
"Other" and "Negative" dislocation are all drivers not classified as either "Positive" or "Nil".

Both the Single Omit and the Average Class models reflect the relationships between rating factors that exist in current rating plans. In carrying out a new rating plan, a company could elect to alter the emphasis and influence of certain rating factors. To the extent that existing relationships change, the estimated type and amount of dislocations could change. Of course, if there are limitations placed on rating factor use, there may be fewer options for modifying the influence of specific rating factors.

Distribution of Dislocations

As stated earlier, for the population as a whole there is no change in the average premium for any model. Each model is required to be revenue neutral. One consequence of this is that every dollar reduced from one consumer's premium must be added to the premium of another consumer. Figure 3 shows the percent of the population experiencing different levels of reduction and increase in six month Bodily Injury premium.



Note:
"Single Omit-1" uses the Single Omit weighting method to measure the influence of the standard rating factors.
"Single Omit-2" uses the Single Omit weighting method to measure the influence of a set of ratng factors that are primarily the ones currently used by the nine insurers included in this analysis.

Again, we see that there is very little difference between the Average Class and the Single Omit with standardized factor methods. The basic shape of the distribution curve is the classic "bell curve." Most consumers are in the middle and experience either no change, a slight increase, or a slight decrease. The larger and larger increases are experienced by fewer and fewer consumers. Similarly, the larger and larger decreases are experienced by fewer and fewer consumers. Only a small percentage see increases of over $100, and only a small percentage see decreases greater than $100.

For the Average Class method, it is estimated that 23 percent of consumers have a new premium within +/- $10 of their current premium, 57 percent are within +/- $30, four percent see an increase of over $100, and four percent see reductions greater than $100. For the Single Omit with standardized factors method, it is estimated that 24 percent of consumers have a new premium within +/- $10 of their current premium, 60 percent are within +/- $30, four percent see an increase of over $100, and three percent see reductions greater than $100.

The Single Omit without the standardized factors model deviates from the classic "bell curve." The most common result with this model is a slight increase ($10 to $30) in premium. Seventy-three percent of consumers will have a new premium within +/-$30 of their current premium. With this model, relatively fewer consumers see a reduction in premium or a larger increase (over $30) in premium when compared with the results of the Average Class model or the Single Omit with standardized factors model.

Summary and Conclusions

This analysis found that it was possible to make substantial changes to the structure of the private passenger auto insurance market without massive disruptions to the premiums paid by most consumers. Two different approaches to measuring the influence of a rating factor on premium were investigated: the Single Omit method and the Average Class method. There were not large differences in the overall impact of the two weighting methods. The main differences were in the steps required for implementation. The Single Omit method requires substantial computations. The Average Class requires the fairly consistent use of rating factors by all insurers in the market. When insurers' current rating practices were analyzed, no insurer was found to comply with the requirements that auto insurance premiums be primarily determined by the safety record, mileage, and driving experience rating factors. While the safety record factor was the primary factor in most insurers' current plans, miles driven and years of experience vary widely, often ranking well below several optional factors.

The current under utilization of the mileage rating factor was the cause of the greatest amount of non-compliance with the requirements that auto insurance premiums be primarily determined by the safety record, mileage, and driving experience rating factors. At a minimum, it was necessary to double its influence, and one insurer had to have its influence increased by a factor greater than ten times. This current failure to give enough influence to annual mileage is the single most important source of dislocation among all the rating factors.

No method for changing insurers' current rating practices to come into compliance with the requirements that auto insurance premiums be primarily determined by the safety record, mileage, and driving experience rating factors was found that would be free of dislocation. Because of the wide range of current practices, virtually any change that implements the requirements that specific factors have a specific order of influence will cause almost all insurers to have to change in some way. The weighting schemes examined in detail show that about four percent of the insured would pay $100 or more than under current practice for a six month bodily injury premium, while about the same percentage would pay $100 or less. Most consumers would pay about the same or within $30 of their current premium for that coverage.

Both of the two major weighting approaches examined in this analysis result in about the same amount of positive or nil dislocation. Most of the increased premiums fall on those with the poorer safety records, less experience, and greater miles driven. While their opposites (i.e., lower risk drivers) pay less.

Standardization of rating factors was used to implement the Average Class method. Other possible benefits of standard factors include a reduction the arbitrariness of the current rate setting process, leveling the playing field among the insurers, and allowing the regulator to more easily monitor compliance. Standardization of all factors could help to focus competition on strategies other than risk avoidance.

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