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Discussion of Patrick Butler's "Cost-Based Pricing of Individual Automobile Risk Transfer: Car-Mile Exposure Unit Analysis"

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Aside from its hyperacademic title, Patrick Butler's paper on mileage and merit rating of automobile insurance policies provides a nice twist to an old model and a reasonably compelling theoretical argument for the use of mileage as a rating variable. Yet one basic real world truth runs counter to Dr. Butler's view: automobile insurance companies generally do not use mileage as a rating variable, except in the broadest of categories. This is despite the fact that Dorweiler's justification for the use of mileage has been around for more than 60 years.

Because it generally is conceded that classification schemes have become more refined over time in response to competition, why haven't insurers already gone down the path to which Dr. Butler points? I can suppose two reasons: (1) competition doesn't really work; or (2) competition does work and the competitive market finds the use of mileage to be wanting in some respect. In my opinion, the second reason is more likely to be true.

Assuming this second reason is correct, then either the demand for or the supply of mileage rating is too low for it to be used more than it is. On the demand side, it is possible that insurance company customers don't like the notion of having their odometers inspected or of adding an uncertain level of premiums to their already complicated lives; after all, the purpose of insurance is to replace uncertain losses with certain, not uncertain, premiums. On the supply side, the costs of administering a system such as that proposed by Dr. Butler simply

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may outweigh the benefits; I am unaware of any administrative cost studies that would illuminate the answer to this particular question.

Beyond pointing out this basic conflict between theory and practice, I would like to make the following observations on Dr. Butler's analysis:

- While there is likely to be at least some correlation between variation in mileage and variation in claim frequency within a class, the Butler analysis essentially assumes a perfect correlation, disregarding the legion of unmeasurable factors that could account for as much variation as does mileage; Dr. Butler's numerical results should be tempered considerably, therefore, before being used in the real world;

- Dr. Butler is clearly in the right when he notes that the per mile expected risk transfer cost only can be determined if real car-miles of exposure are determined. Any study based on mileage data reported by either insurers or insureds is subject to question. In the former case, this may be due to insurer indifference in reporting correct statistical data when no premium effect is involved. In the latter case, this may be due to insureds' incentive to cheat. Here in Massachusetts, where I currently am employed, we have found that nearly 30% of policies have estimated future annual mileage of zero recorded; on the other hand, nearly 50% of policies have estimated future annual mileage of magnitudes too high to qualify for any rate discount, making it likely that these estimates are unaffected by cheating;

- Again, here in Massachusetts, we have found some evidence of a relationship between annual mileage estimates (which are based on questionable data, as explained above) and merit rating classification under the merit rating scheme used here; in particular, the higher rated (worse) drivers do tend to have higher mileage estimates, in keeping with Dr. Butler's thesis; and

- Finally, Dr. Butler's point (in his section 11) that "Applying a recent claim surcharge to the cents-per-mile class price, however, would constitute a deliberate, random, and unjustifiable increase" seems to argue for the complete elimination of merit rating, which the paper does not justify. As anyone who has listened to a radio talk show can attest, at least some part of the driving public demands merit rating as a way of punishing those perceived as offenders (unless, of course, the caller is one of those on the receiving end of a surcharge, in which case he or she would look on Dr. Butler's article quite favorably). Talk show callers aside, the potential relationship between merit rating classification and other unmeasured variables (aside from mileage) cannot be dismissed based solely on this article, nor can the virtually-impossible-to-measure deference effects of a merit rating scheme.

In summary, Dr. Butler's article, while not quite supportive of all of his conclusions, does make plain the problem of random incidence.
The principle that "cars driven more than class-average miles are over represented in the accident sample" is one that I expect many practicing actuaries frequently forget. I recall an analogous phenomenon from an undergraduate probability class; if one surveys subway riders at random and asks how many days per month they ride the subway, the average answer will be too high an estimate of the population mean because the survey-taker more likely will encounter persons who are frequently on the subway. Of course, if we all rode the subway every day, the incidence problem would go away, as would much of the need for cars and the corresponding mileage and merit rating issues. If Dr. Butler is not starting his own insurance company soon, perhaps he can devote some time to the advocacy of better public transportation systems, thereby reducing the problem he has illustrated so nicely.

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Richard G. Woll*

The purpose of this paper, according to Patrick Butler, is to "demonstrate that the car-mile exposure unit is essential to cost-based pricing of individual risk transfer." On the basis of his demonstration, Dr. Butler advocates changing the exposure basis for private passenger automobile insurance from a car-year basis to a per mile basis. Current auto insurance prices are based on a contract that runs for a fixed period of time, usually a half year. He argues that the basis for the insurance contract for most coverages should be changed to miles driven.

Dr. Butler's demonstration consists of creating a simplified model where there are three types of insurance customers. The first type of customer drives 5,000 miles per year. The second drives 10,000 miles per year, and the third drives 20,000 miles per year. He assumes that the risk process for each customer is Poisson with a frequency of

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one accident per 100,000 miles. For illustrative purposes, he assumes that each claim costs $10,000. He then uses this information to generate the dollars of loss experienced by each customer. This allows him to evaluate the effect of what he calls claim record pricing. This means establishing prices on the basis of prior claim records. He concludes that claim record pricing does not match prices to costs as well as charging on the basis of miles driven. He also concludes from this that “the car-mile exposure unit is essential to cost-based pricing of individual risk transfer.”

Insurance companies currently recognize differences in miles driven by the use of class factors. Dr. Butler argues, however, that:

Modern class plans continue to show very narrow distributions of cars by base price multiplier in contrast to the range in the miles driven (Butler, Butler, and Williams, 1988).

Basing insurance prices on the number of miles driven makes intuitive sense. It is obvious that the difference in rates between two drivers, other things being equal, should be proportional to the difference in the miles they drive. The cost of insuring different auto customers, however, depends not only on how much they drive, but on other factors such as how well they drive, where they drive, and what kind of car they drive.

In addition, the relationship between the number of miles a customers drives and insurance claims is complex. Dr. Butler seems to assume that customers who drive more than other customers have proportionately more losses. That is, he expects a customer who drives 10,000 miles to have twice the losses of a customer who drives 5,000 miles. Allstate’s data, however, present a more complicated picture. Figure 1 shows the relationship between the number of PD1 claims per mile and the number of miles driven annually by a customer. It uses information about the 1991 PD claim experience of Allstate customers in California.2

Figure 1 shows the number of PD claims per mile going from 3.5 claims per 100,000 miles for persons who drive about 1,000 miles per year down to 0.3 claims per 100,000 miles for persons driving 30,000 miles or more. This is in sharp contrast to the constant number of

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1 PD (property damage liability) claim frequency is used because it generally has been found to be the best indicator of underlying accident frequency.

2 Because of the passage of Proposition 103 in California which mandated the use of mileage in rating automobile policies, Allstate sent questionnaires to all its customers to get mileage data. Allstate already had collected mileage information on its customers, but the questionnaire helped to confirm the information.
claims per 100,000 miles assumed in Dr. Butler's analysis. This results in customers who drive about 1,000 miles per year having a claim frequency of 3.5 claims per year per 100 insured cars while those who drive over 30,000 miles have a claim frequency of about 8.0—a relationship of 2.25 to one, rather than the 30+ to one under Dr. Butler's assumptions.

When we turn our attention to other risk factors, we find that mileage is a relatively unimportant source of difference between customers compared to territory and years of driving experience.

Figure 1
PD Claims per Mile by Annual Mileage
Allstate 1991 California Experience

The effectiveness of any auto insurance risk assessment system depends on the extent to which it matches insurance prices to insurance costs. Dr. Butler has demonstrated that the use of mileage as an exposure base in a theoretical world, where all differences in loss experience come from differences in the number of miles driven, is more effective than the use of claim record pricing. He has not demonstrated anything with respect to actual insurance experience.

The effectiveness of automobile insurance risk assessments systems was discussed extensively many years ago. A study by the Stanford Research Institute (SRI) in 1976 entitled The Role of Risk Classifications in Property and Casualty Insurance: A Study of the Risk
Assessment Process developed a means for evaluating risk assessment systems by measuring the variance of expected losses of the partitions each system produces. The most efficient risk assessment system is the one that divides insurance customers into groups with the largest variance in expected losses. We also can evaluate the relative importance of various risk classification factors by measuring the percentage of the total variance each factor explains.

Dr. Butler seems to argue that the primary contributor to the variance of expected losses in the real world is the difference in the number of miles that each customer drives. There is no evidence presented by Dr. Butler, or by anyone else, to show that this is the case. The major case made for mileage in the paper is the repeated observation that insurance risk is transferred, mile after mile, by driving.

Using the SRI approach, the Allstate Research and Planning Center recently conducted a study of risk classification factors in California. The study covered most of the factors customarily used by most companies with the exception of vehicle characteristics. Allstate has collected data on the mileage driven by each customer since 1981, so the study was able to include mileage. Mileage, years licensed, and territory explained over 90 percent of the variance of the classification data included in the study for liability coverages (bodily injury liability, property damage liability, medical payments, and uninsured motorists). Over 55 percent of the total variance, however, was explained by territorial differences. Years licensed explained almost 23 percent of the variance, and mileage explained about 14 percent.

The picture was somewhat different for collision coverage. Territory, mileage, and years licensed again explained over 90 percent of the variance, but mileage explained over 33 percent of the total variance, years licensed explained about 30 percent, and territory explained about 26 percent.

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3 The SRI report states "First, we define a measure of efficiency. Our probabilistic model for actual losses separates the random element of actual losses from the predictable element, the expected loss, that is, claim likelihood and expected claim severity. A perfectly efficient risk assessment process would be one that estimates exactly individuals' expected losses. A process with zero efficiency would not resolve any of the initial expected loss uncertainty. A process with intermediate efficiency will be characterized by the average fraction of the initial expected loss uncertainty it resolves" (emphasis added).

The report continues that: "We find it convenient to use variance to measure uncertainty because of its additive property . . . In words, the expected loss variance in an entire population is equal to the sum of the average expected loss variance within each class and of the variance of the rates (average expected losses) among classes" (SRI, Supplement, p. 200).
Insurance customers with less than one year of experience have the highest losses per car. Losses per car decline each subsequent year. Thus, persons with more years of driving experience have improved loss experience. This, in turn, suggests that an important element in the transfer of insurance risk is how the customer drives. Territory rates, of course, depend on where insurance customers drive.

The Allstate study indicates clearly that how much its customers drive is only part of the overall variance of systematic risk. It is more important than the other two factors for collision insurance, but still accounts for only about one third of the total variance. It plays even a smaller role in liability insurance, the major part of auto insurance costs.

Thus, we do not believe that Dr. Butler has been able “to demonstrate that the car-mile exposure unit is essential to cost-based pricing of individual risk transfer.”

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Author’s Reply to Discussion

The discussions by Messrs. Ruy A. Cardoso and Richard G. Woll question different points in the paper and raise other important issues concerning automobile insurance exposure units that are outside the immediate scope of the paper. Responding to these questions not only calls for expanded consideration of points discussed in the paper, but also requires examination of further consequences of conversion to the car-mile exposure unit and of retaining the car-year unit. The efforts of Mr. Cardoso and Mr. Woll in providing this opportunity and challenge are appreciated greatly.

Reply to Discussion By Ruy A. Cardoso

Mr. Cardoso’s major argument against conversion to the car-mile exposure unit can be paraphrased as follows: if the car-mile were judged superior to the car-year by Dorweiler in 1929 and has not been adopted or even studied since then (over 60 years), then the car-mile unit must have some unidentified fatal flaw. Specific flaws suggested by Mr. Cardoso are (1) the technical failure of future mileage as a
classification variable, (2) the irrelevancy of exposure measurement because competition prevents overpricing, and (3) customer resistance to odometer auditing. Upon examining these suggested flaws, however, one finds evidence that the true fatal flaw that has prevented the use of the car-mile unit is seen only from the perspective of automobile insurers. Adoption of the car-mile unit as an objective standard for measuring transfer of on-the-road risk would curtail price competition severely for larger-premium consumers with broad insurance needs. It also would end the subsidy for this competition currently paid by consumers transferring less than class average risk per car-year.

Mr. Cardoso’s criticism of mileage as a flawed classification variable—i.e., usable only in broadest categories, insurer indifference to integrity of data, incentive to cheat—agrees with company rate hearing testimony previously published; see Butler, Butler, and Williams (1988, p. 388). The problem with this critique is that it misses the point: the subject discussed by the current paper, as well as by the 1929 Dorweiler study, is not classification variables but exposure units. It is necessary, therefore, to clarify the difference between variables chosen to define price classes and the price unit chosen as the unit of purchase to which prices refer.

Gasoline purchase provides a ready analogy to distinguish classification variables from the price unit. Gasoline usually is available in twelve different price classes. The pricing variables that distinguish these classes are three octane levels, self service or full service, and cash or credit payment; thus, $3 \times 2 \times 2 = 12$ prices. Yet the gasoline gallon is the unit of purchase common to all of the price classes. In auto insurance, price classes are defined by variables such as territory, driver characteristics, and use of car. Distinct from such classification variables is the price unit, currently the car-year, but which would be the car-mile after conversion to the car-mile exposure unit. Although classification variables and the price unit have distinct functions, the choices of which to use for assessing the cost of risk transfer are influenced strongly by auto insurance price competition.

In suggesting that competition currently prevents insurance overpricing of cars driven less than average, Mr. Cardoso apparently is taking the well-known fact that competition lowers auto insurance prices for marketing targets and extrapolating it to the public relations dictum that competition precludes overpricing. There is plentiful evidence, however, that insurers’ price competition for customers with more risk to insure has, as its complementary effect, the overpricing of customers with less risk to insure (what Bailey (1960) calls
"skimming the cream"). This effect was described in 1911 by the New York State Legislature's Merritt Committee Report (p. 41) in its examination of the need for regulation of fire insurance pricing:

In a state of open competition the rates adjust themselves not to the hazards but largely to the strength of the insured so that the man of influence, whose patronage is desired, will get his insurance too cheaply, as against the small man who is not in a position to drive a sharp bargain. That is, competition results in discrimination.

Automobile rate hearing records contain admissions that costs are shifted from higher mileage customers to lower mileage customers and from men to women in response to price competition; see Butler, Butler, and Williams (1988, p. 405). For example, in 1982 State Farm testified to the Pennsylvania Insurance Department that in order to keep the price down for its higher mileage customers, the company keeps its low mileage discount to about half the size it should be. State Farm stated:

We're already very competitive on the [lower mileage] class, and we're generally tight on a competitive standpoint on [the higher mileage] class, and if we widen the differential, we're going to hurt ourselves very substantially on the [higher mileage] class of business.

Later in the hearing the State Farm actuary explained:

We like to follow the statistics where we can. The rating law talks about rates which are not excessive, inadequate or unfairly discriminatory, but your rating [law] also talks about doing nothing to prohibit competition in the marketplace, and as a matter of fact, we simply can't—we just can't always follow the statistical indications.

Auto insurers not only keep price differences between risk classes smaller than cost differences to compete for members of the more costly class, but also merge higher and lower risk classes or do not divide classes where such groups are distinguishable. In the latter case, for example, competition for adult men's business explains why nearly all cars in the adult driver classes are unisex-rated despite government mileage statistics, backed by accident involvement data, that show that men's average risk per year is about twice women's average risk per year. The same accident involvement data are said
to require sex-divided prices for youth classes. Rate-hearing testimony also shows that men's prices may be lowered contrary to experienced cost to allow agents to establish good relations with young men who are desirable as future sales targets.

Just as competition works to flatten rather than sharpen class differences, resistance to any real measure of exposure differences within classes also expresses competitive concern for the "man of influence" at the expense of the "small man." The capacity for miles of driving is dependent on income level, which generally determines the ability to buy gasoline and own reliable cars. Because the car-year price unit is the status quo for insurance, the result of choosing this price unit as opposed to one that responds to individual cost can be examined by analogous conversion of the price unit for gasoline from the gallon to the car-year. That is, what would the consequences be for customers if gasoline were sold like auto insurance?

With gasoline sold by the car-year, everybody with cars in the same class would pay a dollars per car-year price based on the cost per car of supplying gasoline for that class in previous years and adjusted for expected change in gasoline cost and, as currently done for auto insurance, any trend toward increased or decreased driving. Payment in advance for a car-year's worth of gasoline would allow customers to draw gasoline as needed from the class pool. Sale of gasoline by the car-year, however, would lead to problems analogous to the affordability breakdown that occurs in areas where the car-year price of auto insurance is high.

With gasoline prices set to cover the anticipated car-year average cost of each class, above average users of gasoline would experience a decrease in their gasoline expense paid by an increase in gasoline expense for below average users. Once accustomed to the benefits of unmetered gasoline, the above average user would object to any expense and accountability that using meters on gasoline pumps would entail, as Mr. Cardoso observed would occur with the use of odometers to earn insurance premiums. If the increase in annual gasoline cost per car were to force some below average users to give up cars, however, class average gallons per car-year would rise. A rise in average consumption would raise the cost of gasoline per car-year and would force still more below average users to give up their cars, causing the gasoline cost per car-year to rise even more. This death spiral effect that results when prices are not tied to a unit of individual consumption first would become apparent where the annual prices are highest, as is happening currently with auto insurance in some urban areas.
Surcharging the yearly gasoline bill of every tenth customer in a class so that the other nine can receive a customer retention discount would be analogous to the randomness of auto insurance merit rating. (Although Mr. Cardoso defends merit rating as having possible deterrence effects, customer retention is an obvious purpose. If discounts for claim free years were really risk-related, eligibility would transfer between companies. Customers generally are puzzled to discover that it does not.) With gasoline sold by the gallon instead of the car-year, however, the classification variables that set prices are certain, objective, obviously related to a cost that can be evaluated by customers, and not easily manipulated to price discriminate between customers. From the auto insurers’ viewpoint, the real fatal flaw in car-mile pricing is that it would inhibit cost shifting within classes by making the cost of individual risk transfer as understandable and controllable as the gasoline cost of automobile operation.

The public demand for driver-record pricing voiced on call-in radio talk shows to which Mr. Cardoso refers is a political response based on the only information available to consumers. Charged by the car-year, auto insurance is experienced as a flat tax on car ownership at prices based on group characteristics. By appearing to take the individual into account, driver-record pricing competes, as the paper notes, with the idea of making the car-mile the price unit for individual risk transfer.

Reply to Discussion By Richard G. Woll

Two sentences early in Mr. Woll’s discussion transform what purports to be a critique of the paper’s subject—the car-mile as the price unit for individual risk transfer—into a critique of a topic that the paper does not address—the problematic estimated future mileage discount classes with the car-year as the price unit. (These discounts are used by some insurers, but were rejected as inherently unenforceable by other insurers after several decades’ use; see Butler, Butler, and Williams (1988, p. 388)). “It is obvious,” Mr. Woll states, “that the difference in rates between any two drivers, other things being equal, should be proportional to the difference in the miles they drive. The cost of insuring different auto customers, however, depends not only on how much they drive but on other factors such as how well they drive, where they drive, and what kind of car they drive.”

While the qualifying phrase “other things being equal” in the first sentence could refer to the purpose of classifications such as those cited in the second sentence, the word “however” in the second sentence suggests a rebuttal of the first. Together they seem to imply
that the amount driven is not a measurement but a factor, i.e. a classification variable arguably related to risk, as are driver experience, garaging territory, and car type. For the remainder of the discussion, Mr. Woll criticizes the car-mile exposure unit as if it were a mileage classification variable (which it is not) to be compared with other car-year classification variables as has been done in his research at Allstate.

The basic premise of the paper is that the car-mile must work in conjunction with risk classification as the exposure unit to measure the cost of individual risk transfer. The abstract states that odometer miles multiply “a cents-per-mile rate based on class experience” and that the “per mile cost of individual risk transfer is a class property.” The essential relationship of individual exposure measurement to risk classification is emphasized in every section. It is from this perspective that the main issues raised by Mr. Woll will be addressed. These issues are within-class proportionality of cost to miles driven; observed decreasing claim rates per mile with increasing annual mileage; and car-mile costs by territory classification.

The question of proportionality of cost to miles driven is raised by Mr. Woll’s observation that Dr. Butler “expects a customer who drives 10,000 miles to have twice the losses of a customer who drives 5,000 miles.” This correctly represents how the car-mile unit works if the cars driven different distances are classified identically (and have the same coverage).

The proportionality assumed by the current car-year system, ostensibly for administrative convenience, is that within-class cost is proportional to the time period the car is insured in units of car-years. This assumption produces widely divergent per mile costs for cars identically classified. Table 1 illustrates this using Mr. Woll’s 5,000 and 10,000 miles per car-year example. The cars driven the two distances per year are garaged in the same territory and are classified identically by driver (adult unisex) and use (pleasure with limited commuting to work). The premium and per mile costs of 10,000 miles of coverage driven at 5,000 miles per car-year under two arrangements are compared with the cost of driving 10,000 miles in one car-year. Three different premiums are paid for 10,000 car-miles of exposure.
Table 1 shows that factors not directly related to risk, such as number of cars in a household and how intensively they are used within time periods, determine large differences in what is charged per mile of exposure to risk of loss for cars in the same territory and driver risk class.

The requirement endorsed by Mr. Woll that the number of price units should be proportional to expected losses, other risk factors being equal, leads to the absurd conclusion that insurers currently expect a customer who drives 10,000 miles over two years or in two cars in one year to have approximately twice the losses as a customer driving one car the same distance in one year.

Mr. Woll raises the issue of decreasing claims per mile with increasing annual mileage by presenting Allstate study data in his Figure 1. By raising this relationship as an objection to the car-mile as a price unit, Mr. Woll implies that the same cents-per-mile price would be applied to all cars and therefore would overcharge the owners of cars driven more intensively in a year relative to owners of cars driven much less in a year. This objection, however, ignores the fact that cents-per-mile prices would depend on each car’s risk classification.

As in prior studies with similar results, the results shown in Mr. Woll’s Figure 1 are obtained with data that either are unclassified or are classified only by driver sex; see Butler, Butler, and Williams (1988, p. 266). As a consequence, drivers at the extremes of the age range, who have considerably higher than average accident rates per mile and also average much less driving, would be over represented at lower mileages without classification by driver age. (The paper points out that car-miles of exposure randomly sampled by accidents would be biased toward the cars of such driver groups.) Concurrently,
the higher mileage data would be biased to cars used predominantly on limited access highways with lower accident rates per mile. As Mr. Woll points out, it is not just miles driven that determine risk transfer cost, but territory, driver, and use of car, all of which require risk classification for evaluation. Conversion of class prices from dollars-per-year to cents-per-mile demonstrates this essential relationship.

Table 2 compares the conversions of two existing car-use classes to cents-per-mile prices. All that is necessary for the conversion is an average mileage value for the class. At averages assumed for the two classes, the difference in the cents-per-mile class prices shown in the table approximate the threefold decrease in per mile claim rates with the fivefold increase in intensity of car use from 5,000 miles to 25,000 miles per year shown by the Allstate data in Mr. Woll's Figure 1.

<table>
<thead>
<tr>
<th>Class</th>
<th>Territory Car-Year Base Price*</th>
<th>Multiplier**</th>
<th>Car-Year Price</th>
<th>Average Miles per Car-Year*</th>
<th>Calculated Price per Car-Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasure</td>
<td>$500</td>
<td>.95</td>
<td>$475</td>
<td>5,000</td>
<td>9.5¢</td>
</tr>
<tr>
<td>Business</td>
<td>$500</td>
<td>1.40</td>
<td>$700</td>
<td>25,000</td>
<td>2.8¢</td>
</tr>
</tbody>
</table>

* Assumed values
** Adult unisex driver class. Multipliers from the California manual of State Farm Mutual Automobile Insurance, effective 1/15/91

What determines per-mile risk for a car is not the number of miles it is driven within an arbitrary time period (one year), but the average conditions under which the driving is done. Although intensity of car use may correlate with driver age and car use, classification is essential to determine the cost of insurance coverage per car-mile for any set of driving conditions. The car-mile unit for measuring the cost of risk transfer is also essential to meaningful territorial classification.

As though the car-mile were a classification variable, Mr. Woll states that "[W]e find that mileage is a relatively unimportant source of difference between customers compared to territory." An example shows, however, that classification by territory depends on the car-mile exposure unit—as distinct from mileage classification—to have meaning for individual risk transfer. Table 3 shows the dollars per car-year prices for a high priced territory and a low priced territory in California for cars in the same driver and use

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TABLE 2
Car-Mile Prices For Two Use Classes

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class. The ratio of high to low prices per car-year is 4.4, presumably representing the greater traffic density in Los Angeles and other differences in conditions and costs. The cents-per-mile costs for car owners also is shown in both territories at three mileage amounts.

**TABLE 3**

<table>
<thead>
<tr>
<th>California Territory</th>
<th>Car-Year Price for High Annual Mileage*</th>
<th>Car-Mile Cost to Owner by Miles Car is Driven in Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3,000**</td>
</tr>
<tr>
<td>13 Northern Counties</td>
<td>$265</td>
<td>7.6¢</td>
</tr>
<tr>
<td>Los Angeles City</td>
<td>$1172</td>
<td>33.7¢</td>
</tr>
</tbody>
</table>

* State Farm manual effective 1-15-91. Minimum coverage, adult unisex driver and car use profile from California Insurance Dept.'s 1990 Auto Premium Survey

** Discount for estimated future mileage less than 7,500 miles applied

If it is assumed that the average exposure for the class in both territories in Table 3 is 12,000 miles per car-year, conversion to the car-mile unit means that all of the northern counties cars would be paying 2.2 cents a mile and all of the Los Angeles cars in the class would be paying nearly 10 cents a mile, thus preserving the difference in territorial risk transfer costs.

In contrast to the differences between territories in cents-per-mile costs at class average mileages, the northern counties owners of cars driven 3,000 miles in a year pay more than seven cents a mile while owners of Los Angeles cars driven 20,000 miles in a year pay less than six cents a mile. The meaning of difference in risk by territory is lost if more is paid per mile for individual cars in territories with low traffic densities than is paid per mile for individual cars in territories with the highest traffic densities.

Mr. Woll devotes a considerable portion of his critique to discussing his study of statistical measures for comparing classifications of car-year data, citing evaluation methods developed by the Stanford Research Institute (SRI). Although the SRI study (1976) did not evaluate the car-mile unit as an alternative to the car-year unit, a major finding from its empirical study of nine years of individual driver accident records establishes strong limitations on the ability of classification by year to distinguish the cost of individual driving risk. The study corroborates that the most powerful class separation is driver sex, with men's average accident likelihood per year about twice the women's average. Despite this large class difference, how-
ever, the distributions of individual accident likelihoods per year for men and women completely overlapped, with 13% of women having likelihoods greater than men's average and 28% of men having likelihoods less than women's average. These overlapping distributions and averages show characteristics that are similar to the distributions of men's and women's annual mileages in relation to the approximately 2:1 difference in their average miles driven. Eleven percent of women exceed men's average mileage, and 24% of men drive less than women's average mileage; see Butler, Butler, and Williams (1988, p. 396). Individual miles of driving cannot be predicted from experienced class averages, by driver sex, or in any other way. (See the paper for the characteristics of individual mileage listed by Bailey and Simon.) The miles that individual cars are driven, however, are recorded on their odometers as the measure of individual risk transferred. The expected cents-per-mile cost of risk transfer depends on statistically reliable actual class experience.

Mr. Woll's discussion of the car-mile price unit as if it were a classification variable has provided an opportunity to show why the car-mile exposure unit is essential to meaningful classification for individual risk transfer. Dollars-per-year prices for example risk classes that purport to distinguish differences in risk by territory, driver, and car use show large individual variability in cents-per-car-mile costs for reasons not directly related to risk. Therefore, not only is the car-mile exposure unit essential for cost-based pricing of individual risk transfer, but its use is essential in order for risk classification variables (factors) to have meaning for individual risk.

References


Merritt Committee. Joint Committee of the Senate and Assembly of the State of New York Appointed to Investigate the Affairs of Insurance Companies Other Than Those Doing Life Insurance Business, Report, Assembly No. 30 (1911).