Are Drivers of Uninsured Vehicles "More Dangerous"? A Sampling Paradigm to Resolve Conflicting Evidence

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For decades state legislators have called for mandatory insurance laws, some legislators arguing their view that drivers of uninsured vehicles are high risk and a public safety problem.[1] In opposing such laws, however, insurers respond that drivers of uninsured cars closely resemble drivers of insured cars.[2] Despite opposition by insurers, to date 48 states have adopted mandatory insurance. Since many vehicles continue to be driven illegally without insurance, the character of drivers using uninsured vehicles continues to be studied and debated.

Many of the studies involve how to assess the magnitude of uninsured driving. The discrepancies between methods were brought out in testimony in 1999 to the Texas legislature by a former Utah legislator. He spoke in support of a measure Utah adopted in 1995 to cross check insurance records monthly against vehicle registration records. This is how he described the situation before and after implementing the law.

> Mr. Kelly Atkinson: When I asked as a [state] representative what the uninsured motorists population was in the state of Utah, I was told by insurance companies that it was 3%….[T]he Commissioner of Public Safety told me it can't be 5% [sic] because at the time of accidents 9% of people we checked that get involved in accidents don't have insurance. When we did our first cross reference against those vehicles that were registered against those vehicles that had insurance, 23% of the citizens that had registered their vehicle did not have insurance. (Butler, 2000, page 22.)

The testimony cites all three methods this paper examines: 1) the accident involvements of uninsured vehicles (9% in Utah); 2) the insurance industry claims method, which as updated for 1995 actually agrees closely with the 9% figure; 3) the very discrepant 23% uninsured vehicles based on comparing insurance and state records. After examining the three methods, I'll return to the implications of this large 9% versus 23% discrepancy.

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[1] Apparently what impels the slow but inexorable trend to mandatory insurance nationwide despite serious opposition by insurance trade associations is that typically each state legislator hears from a handful of constituents every year who are angry at being involved in an accident with an uninsured vehicle. At the least such a collision, even if covered by the constituent's own physical damage insurance, means loss of the deductible which otherwise would have been paid by the property damage liability insurance of the other car.

[2] Analysis by Harrington 1994 generally supports the industry's other arguments against mandatory insurance on grounds of large enforcement costs relative to any premium savings, reduced respect for law, and burden to low-income car owners.

This analysis also examines evidence used to support the assumption that drivers of uninsured vehicles (UVs) are less cautious than drivers of insured vehicles (IVs).[3] But a few researchers worry that this assumption contradicts the general theory that absence of insurance makes people more cautious, not less.[4]

A major source for the idea that drivers of uninsured cars "tend to be more dangerous drivers"—as a California law professor told a consumer conference (Sugarman 1998, p. 9)—appears to be the California Department of Motor Vehicles. In particular a 1981 department report by Kuan and Peck concludes that "as a group, uninsured *accident* motorists are a high risk group," (p. 8, emphasis added). The report is still being cited in this regard, but without the important qualifier *accident-involved* (*A-I*).[5]

Kuan and Peck actually make two comparisons. One validly compares one sub-group of A-I drivers to another sub-group of A-I drivers, while the other invalidly compares one sub-group of A-I drivers to the entire licensed-driver population. The problem with the invalid comparison is apparently not obvious to those citing it, suggesting that the significance of the valid comparison may not be well understood. We'll start with the valid comparison which uses the accident-involvement method.

On-Road Populations vs. File-Record Populations

Insurance status by California zip code

Kuan and Peck's valid comparison used the zip-code residence of drivers involved in reported accidents (occurring anywhere in California[6]). As the UV rate for a zip code, the report used the

[3] The designations "uninsured vehicle" and "insured vehicle" follow Hunstad's (1999b) recommendation. He points out that nearly all automobile insurance attaches to vehicles, not drivers. This means that the units of insurance premium rates and cost accounting are car years. When a policyholder adds or removes a vehicle from a policy, the premium units change accordingly. On the other hand, when a driver is added or removed from the policy, the insurance rate per car-year unit may or may not change depending on whether or not there is a change in driver category that affects the car's classification—but the number of car-year units of insurance do not change. Khazzoom (1999) also notes that the term "uninsured motorist" is ambiguous because a given driver is "insured" or "uninsured" depending on the insurance status of the car being driven.

[4] In fact, Cohen and Dehejia 2004 explicitly tested this theory with respect to mandatory insurance. They found evidence that mandatory insurance may decrease caution because "increases in the incidence of automobile insurance…have significant negative effects on traffic fatalities," (page 357).

[5] Jaffee and Russell 1998 (p. 105) state that Kuan and Peck's "evidence indicates that uninsured motorists actually have a higher accident frequency on average than insured motorists." Khazzoom 1999 (p. 83) states that Kuan and Peck "found that, compared to the average driver in California, the uninsured driver has a worse accident record." Kuan and Peck themselves did not seem to appreciate the need to distinguish that their data referred to accident-involved drivers when they summarized that "[c]ompared to the average California driver, the financially irresponsible driver was found to have a much worst prior accident record."

[6] The author has not yet assessed the extent to which accident involvements in states other than the state of driver licensing are routinely reported back to the licensing state. However, it is certain that insurers assign claims generated anywhere coverage extends (including Canada, but usually not Mexico) to the zip code or insurance territory where the owner of the insured car lives. Examples of confusion about this auto insurance protocol appear in refereed insurance journals.

percent of all *A-I* drivers from the zip code who were driving a UV when the accident occurred. (Statewide in California this UV rate for *A-I* drivers was about 15%. In Texas this rate has stayed about 20% for a decade or two.)

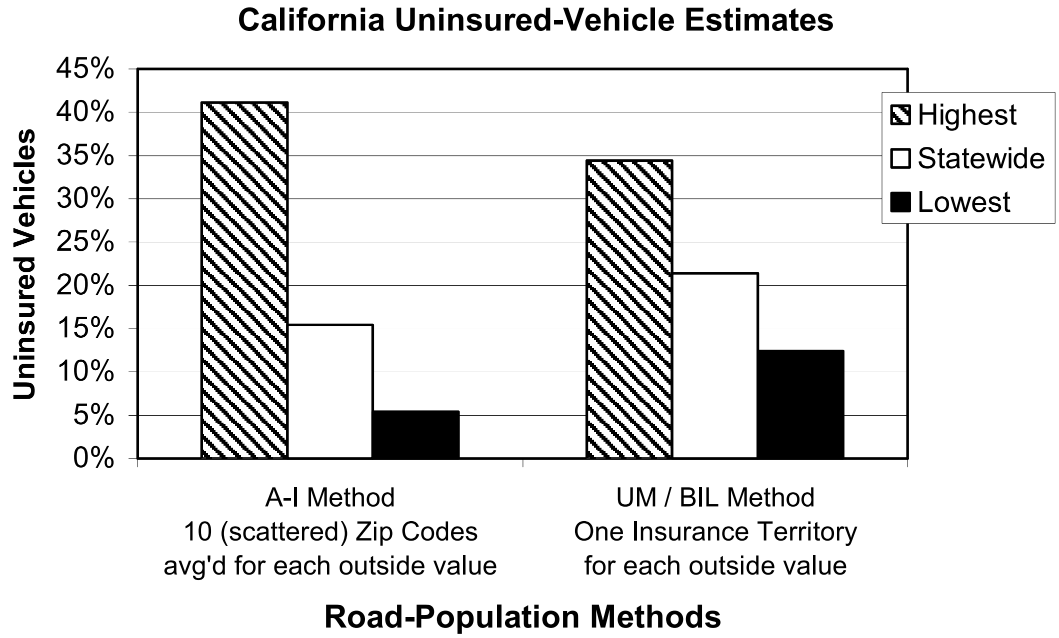
But what does this kind of UV rate for *A-I* drivers signify about populations of UVs and IVs? If accidents are logically viewed as an on-the-road random sampling of all vehicle miles driven—each mile driven has a probability of accident—then the UV percent in a state's *A-I* population is an estimate of the percent of the state's total annual vehicle miles driven that was driven by UVs. This is the UV rate that should be of interest to lawmakers because the ultimate purpose of mandatory insurance is to assure that each vehicle-mile driven is insured.

Table 1. California geographic variation in UV rates by two methods.

Kuan and Peck 1981 (Of 1886 state zip codes, used 755 with credible numbers of accident involvements—1,000 or more—by resident drivers in 4.5 years)			All-Industry Research Advisory Council 1984	
Driver's Zip-Code Residence in California	Percent of all A-I drivers who were driving UVs		Auto insurance territory	100 x Ratio of UM to BIL Claim rates (claims per 100 insured car years)
Highest ten zip codes averaged, 7 in City of Los Angeles	41.1		Los Angeles Central (Highest ratio)	34.3
Statewide	15.4		Statewide	21.4
Lowest ten zip codes averaged – in various cities, Alamo to Pasadena	5.4		Santa Barbara County (Lowest ratio)	12.4

Stratifying an *A-I* population would correct for driver age bias. There should be little driver-sex bias because at each age men and women have about the same driver-mile risk rates. (One estimate of the accident risk—and on-road "sampling"—rate for adult drivers is 4 to 5 accident involvements per million miles driven compared with per-mile rates for teenage drivers of both sexes that are six or seven time more. Williams 1999) Of course, there are reporting and other sources of bias in this method.

Figure 1. Source is Table 1.

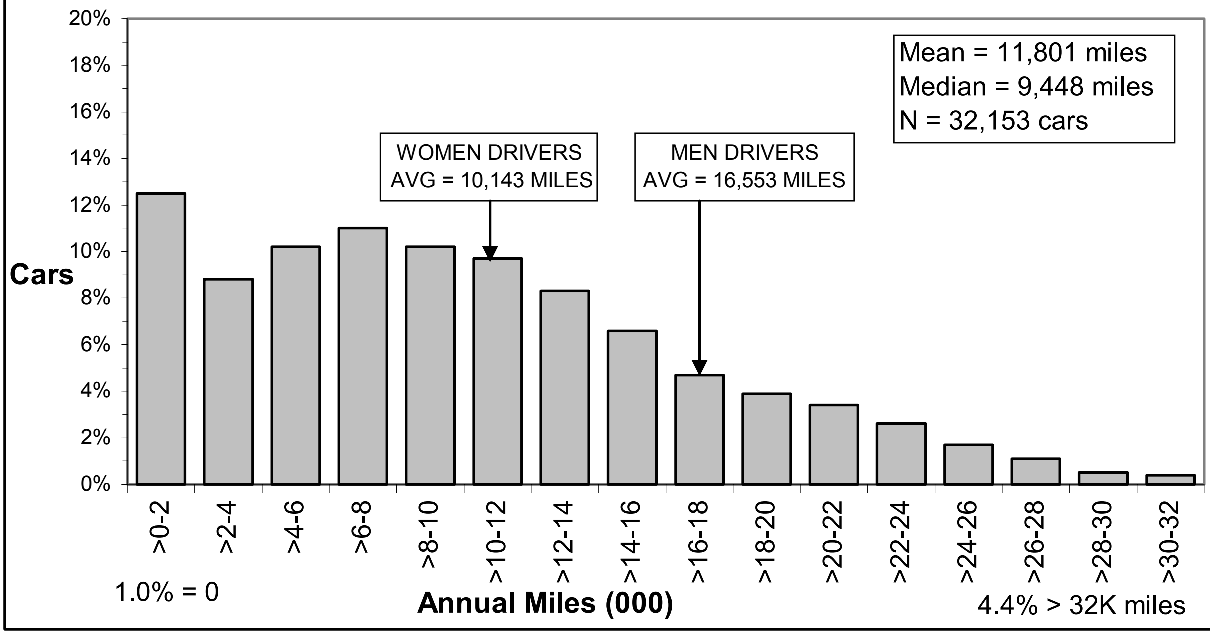


Similarly to the method of comparing the insurance status of *A-I* vehicles to each other, the insurance industry compares the claim rates of two coverages, uninsured motorist (UM) to bodily injury liability (BIL) to each other. As shown in Table 1 and Figure 1, the results are in general agreement, taking into account that insurance territories encompass multiple zip codes and so lack the resolution of the extreme values shown by single zip codes. Even though claim data are kept on a file-record (car-year) basis, this method similarly involves a road sampling paradigm as explained in a later section.

Accident-involvement predicted by driver sex

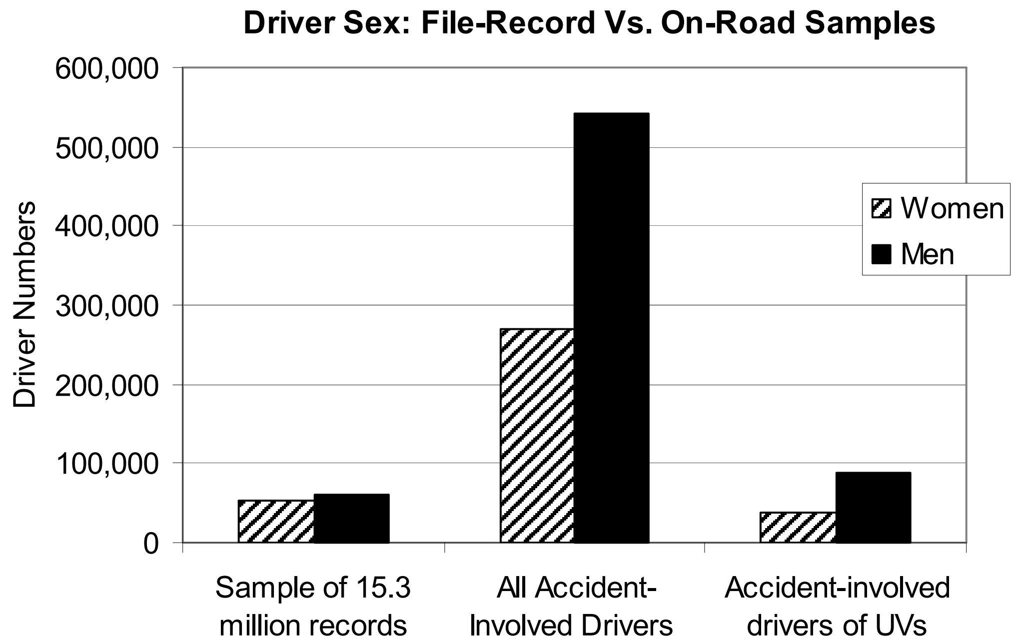
Where the 1981 Kuan and Peck report misleads readers is in comparing drivers of UVs to the entire licensed population of California drivers. The drivers of UVs profiled by the report are all *accident-involved* (*A-I*) drivers. They constituted a subset of 125 thousand *A-I* drivers of UVs from what constitutes an ON-ROAD accident sample consisting of about 820 thousand drivers involved in accidents reported to the state in 1978. But Kuan and Peck compare this UV driver subset of the *A-I* driver population to a FILE-RECORD sample (113 thousand drivers), randomly drawn from the state's file of 15 million licensed drivers. In this population, to judge from the federal Nationwide Personal Transportation Surveys, some license-holders do not drive at all and a majority (60% or so) drive less than average.

Figure 2. *Distribution of Cars by Odometer Annual Miles.* Source: Nationwide Personal Transportation Survey, 1995.



Relative to the annual mile averages for file-record populations of licensed drivers and registered cars, on-road random samples of the vehicle miles driven by members of these file-record populations must be inevitably biased to much higher annual mile averages and concurrently biased to categories that average more miles per driver or per car, such as men versus women, and new cars versus old cars. The Kuan and Peck report states that 70% of the *A-I* drivers of UVs were men versus 53% men in the licensed population. It is this and other comparisons to the general population of licensed drivers that seem to support the conclusion that drivers of uninsured cars are a high annual risk group.

Figure 3. Source is Kuan and Peck (1981) & Calif. Hwy. Patrol (1980).



But instead if *A-I* drivers of UVs are compared to *A-I* drivers of IVs—as Kuan and Peck 1981 did for zip code comparisons—there seems to be little difference between them. For example, according to the California Highway Patrol accident report for 1980, men, as the same 53% of licensed drivers, had 69% of the reported involvements in injury accidents, virtually the same as the 70% men Kuan and Peck give for *A-I* drivers of UVs. Thus, properly compared, drivers of *A-I* UVs are very similar to drivers of *A-I* IVs. In fact, this similarity is highlighted in some of the insurance industry's periodic reports on uninsured motorists. The All-Industry Research Advisory Council concluded in 1984 (p. 2) that "the most striking characteristic of the uninsured is that they closely resemble insured motorists, for the most part. For example, male drivers account for about two-thirds of all the auto accidents, among the insured population as well as among the uninsured group."

Accident rates per year predicted by accident-involvement history.

In regard to the driving record of *A-I* drivers of UVs, Kuan and Peck also compare them to the file-record population of all licensed drivers, rather than to the driving record of the on-road sample population of *all A-I* drivers.[7] But this relationship between a current accident involvement rate per 100 drivers and accident history is what insurers find for all insureds.

[7] Compared with a file-record sample of licensed drivers that averaged 0.06 reported accidents per year in the previous 3 years, the *A-I* drivers of UVs averaged 0.10 accidents per year. But Kuan and Peck did not compare this subgroup of *A-I* drivers with the accident histories of all *A-I* drivers including the nearly 85% who were driving IVs at the time of the reported accident. (It also should be noted that the drivers license file-record sample had only 22% drivers younger than age 25, while in the UV sub-group of *A-I* drivers 38% were younger than 25.)

Subgroups defined by recent claim history invariably have higher group claim rates in the coming policy year.

Systematically, insurers find that if the cars that have had a claim in the past three years are sorted from a main pool that produces, for example, 5 claims per 100 car-years, the sub-pool of these cars produces 7.5 claims per 100 cars in the following year, a 50% increase from the original average.[8] Also, as a consequence of such sorting, the average annual risk of the large claim-free pool decreases about 7%.[9] Analysis shows, however, that both changes are inescapable byproducts of the annual mile mixtures of cars inherent in today's car-year insurance pools.

The occurrence of traffic accidents can be modeled as a process of random sampling with replacement. The model may be pictured as placing 100 black balls (cars) in an urn. One ball is drawn at random to represent an accident involvement, and then replaced in the urn and stirred prior to drawing the next ball so there is a chance of individual balls being drawn more than once (having multiple accidents). Before a ball is replaced, however, its color is changed from black to white (first accident), then from white to green if drawn a second time, then from green to red for a third draw of the same ball. In order to model the record produced by an annual risk of 5 accidents per 100 cars for three years, 15 draws and replacements are made. Probability theory predicts that, provided the draws are random (colorblind), about 86 of the balls will still be black (no accident), 13 white, 1 green, and 0.05 red (which if the experiment were scaled up from 100 to 10,000 balls would be 5 red balls). Note that none of the 100 balls had a risk different from any of the others of being drawn (0.01 each time), whether or not it had been drawn once or even several times before. Therefore sorting balls by color for a further experiment would not affect results. So why in actual insurance pools is the average annual risk greater (typically by 50%) for sub-pools of cars that have produced claims?

Unlike balls in an urn, cars assigned to an insurance pool differ from each other by the number of miles each is subsequently exposed on the road to being drawn at random. While accidents randomly pick low annual miles cars in the pool along with middle- and high-miles cars, obviously an accident sample of the pool will not represent the mix of cars in the pool but the proportions of these cars that are on the road. Therefore, the road sample of cars in a pool will be biased to the cars driven more miles. A model illustrates the biasing process.

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[8] A 50% increase in claims per 100 car-years may seem large, but very large majorities in both the prior-claim subclass and the claim-free subclass will have a nearly identical experience in the subsequent rating year: 92.5% cars compared with 95% cars respectively will be claim-free. The difference between the claim-free rates is less than 3%.

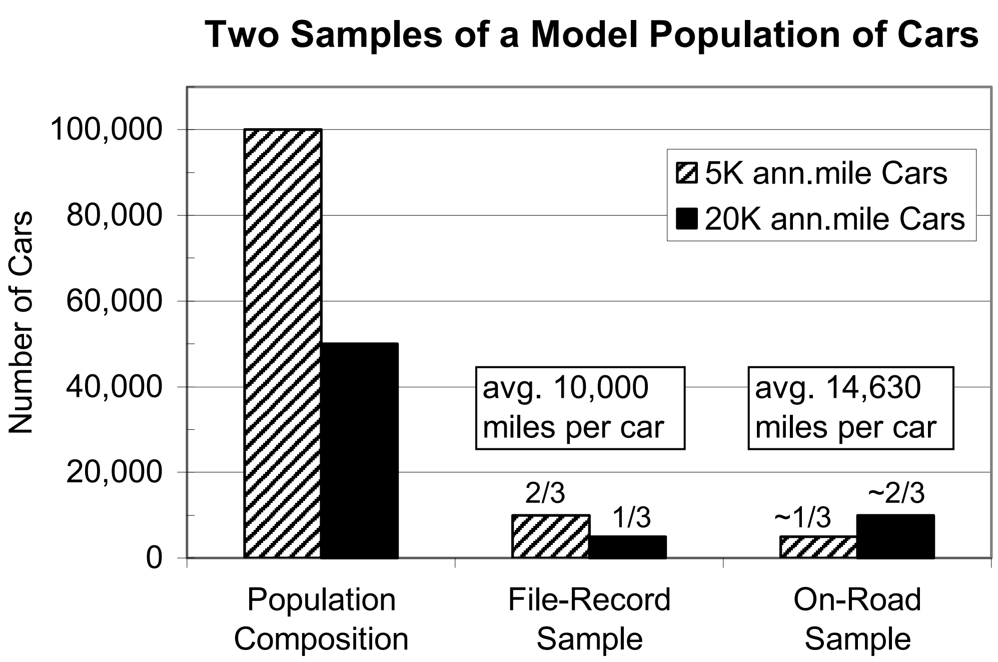
[9] Seven percent is calculated from the model that follows. According to the Casualty Actuarial Society, "accident-free or claim-free drivers usually save at most 5%," Butler and Butler (1989, p. 229). Therefore, insurer promises of 15% to 20% savings for drivers with no recent claims depend on having an inflated base price from which to "discount."

To approximate the positively-skewed distribution of cars by annual miles shown above in Figure 2, assume a two-component insurance pool with two-thirds of cars driven 5K miles a year (low annual risk) and one third driven 20K miles a year (high annual risk). This mix produces a pool average of 10K miles per car. But the proportion of miles added to the pool by the 5K mile and 20K mile cars is just reversed from the proportion of cars in the pool—2/3 of the miles added are by the 20K mile cars and 1/3 by the 5K mile cars. In other words, the proportion of cars exposed on the road to risk of accident is just reversed from the proportion in the insurance pool. Therefore, an accurate random sample of the proportion on the road will consist of two-thirds 20K mile cars and one-third 5K mile cars. (If the sampling rate is assumed to be 5 claims per million vehicle miles, then the 5K mile and 20K mile cars have an annual accident risk of 0.025 and 0.10 respectively, which averages 0.05 for the pool.) So randomly sampling by accident produces a sample with this proportion and an annual miles average of about 15,000 miles, a 50% increase over the 10,000 mile average for the unsorted pool. The premium distribution of cars by claim record category after random sampling for three years is given in Table 2 and is also shown below in Figure 4.

Table 2. *Redistribution of Cars by Premiums.* Source: Calculation by author.

Pool	Avg. ann. miles	Relative premium	Distribution of Cars (%)		Proportion of 5,000-mile cars in pool
			5,000 ann. miles cars (Low Risk)	20,000 ann. miles cars (High Risk)	
Unsorted pool	10,000	1.00	66.7	33.3	2/3
Redistribution by 3-year record at 5 claims per million vehicle miles					
No-claims sub-pool	9,280	0.93	61.8	24.7	~2/3
Claims sub-pool	14,630	1.46	4.8	8.6	~1/3

Figure 4.



Insurance Claims for Sampling UV Miles

Predictive irrelevance of fault

In all of the accident involvement considerations above, no mention of whether or not being judged at fault needs to be a factor taken into consideration. In fact, insurance data show that just being involved an accident both shows exposure to risk on the road and also for subgroups indicates the relative number of miles being driven on average by these subgroups. Insurance data and reports show the correlation between future claim rates equally strong with past claims regardless of whether the insured was negligent for a liability claim or was not negligent and collected on a UM claim.

Such correlation becomes the subject of legislative and regulatory debate because the use by insurers of a UM claim as a basis for increasing a liability premium is controversial. It conflicts with the incorrect widespread belief that a small class of negligent drivers—rather than random negligence by all drivers—causes automobile accidents. By this popular logic, a driver who has been judged to have been non-negligent in an accident should not be subject to a premium surcharge. Insurers continually point out to legislators and regulators that such surcharges are justified by experience. For example, in 1992 the National Association of Independent Insurers, in objecting to a proposed Texas insurance department restriction on the practice, testified that "not-at-fault accidents are as effective as at-fault mishaps in predicting future insurance loss claims."

Much earlier, insurance industry testimony to Congress in 1967 (House Judiciary Committee, p. 82) cited overwhelming evidence of the predictive irrelevance of fault. Referring to an industry study six years before involving over 1 million cases, a company official testified that the study "established beyond the shadow of a doubt that the individual who is involved in automobile accidents, regardless of whether he appears to cause them or not, is much more likely to have accidents in the future than is the person who is accident free….[I]nvolvement in an accident regardless of who was at fault, was the important consideration."

Insurers' claim-rate method of UV estimation

The industry's ratios of UM-rates to BIL-rates across states and time were used for the percent uninsured response variable in studies of factors affecting compliance with mandatory insurance by Ma and Schmit (2000) and by Cole et al. (2001), and as a variable by Cohen (2004) in assessing the effect of insurance on traffic fatalities. Each of these studies appears to accept the method at face value and without discussion of any assumptions or shortcomings.

An analysis of the industry's method of ratioing UM to BIL claim-rates per 100 insured car-years (claim frequencies) shows that the method also is an on-road sampling estimate of the percent of UV miles in the total vehicle miles traveled. The industry's explanation uses an example of 10,000 vehicles, 1,000 of which are uninsured. All these vehicles generate at-fault accidents at a rate of 5 per 100 cars per year (a frequency of 0.05 per car year). The explanation concludes that "the ratio of UM to BI claim frequencies measures the *probability* that a given injury to an insured car occupant will have been the fault of an uninsured motorist." (Insurance Research Council 2000, page 2. Emphasis added here.)

The industry's implicit assumption that for each driver the chances of being found negligent and not-negligent are equal is supported by insurance company experience: the annual rates per insured car of BIL and UM claims—the payment of which require the negligence and non-negligence respectively of the covered car's driver—vary up and down *together* across zip code, credit score, claim record, and other insurance cost categories.

Consider accidents as random sampling of vehicle-miles. In two-car accidents, there will be a draw of two car-miles in succession.

A = Number of two-car accidents over total vehicle miles driven.

M_I = Total vehicle miles with BIL coverage.

M_U = Total vehicle miles without BIL coverage.

f = Proportion of M_I miles with UM coverage. (Typically this is about 80%.)

N_I = Number of cars with BIL coverage.

$\bar{m}_I$ = Average miles per car-year for cars with BIL coverage. $\therefore N_I = \frac{M_I}{\bar{m}_I}$

$N_I{}'$ = Number of cars with UM coverage.

$N_I' = \dfrac{fM_I}{\bar{m}_I}$, assuming BIL insured cars with and without UM coverage average the same number of miles per car year.[10]

The total probability distribution of accident pairs with coverage attributes of interest is:

$$\frac{M_I M_I + M_I M_U + M_U fM_I + M_U\left(1-f\right)M_I + M_U M_U}{\left(M_I + M_U\right)^2} = 1$$

With the convention that the first vehicle mile drawn for the accident pair is negligent and the second vehicle mile drawn is non-negligent, in the probability expression above the first two terms in the numerator generate BIL claims, the third term generates UM claims, and the fourth and fifth terms generate no claims because no coverage is involved.

$$\text{The number of UM claims per car} = \frac{A}{N_I'}\cdot\frac{M_U fM_I}{\left(M_I+M_U\right)^2} = \frac{A\bar{m}_I}{fM_I}\cdot\frac{M_U fM_I}{\left(M_I+M_U\right)^2}.$$

$$\text{The number of BIL claims per car} = \frac{A}{N_I}\cdot\frac{M_I M_I + M_I M_U}{\left(M_I+M_U\right)^2} = \frac{A\bar{m}_I}{M_I}\cdot\frac{M_I M_I + M_I M_U}{\left(M_I+M_U\right)^2}.$$

Dividing the two claim rates cancels all variables but total miles driven by uninsured and insured vehicles:

$$\frac{\text{The number of UM claims per car}}{\text{The number of BIL claims per car}} = \frac{M_U}{M_I + M_U} = \text{the proportion of vehicle miles driven in UVs.}$$

The similarities should be noted of this claim rate ratio method and the accident-involvement method. Although both use annual records of the random sampling results of accidents and claims, by ratioing the involvements and claim rates to each other the effects of differences in miles of exposure are validly estimated.

Claim-Sampling of Miles vs. Insurance File Records

The foregoing analysis has validated two methods—comparing accident-involved groups to each other, and ratioing claim rates—for estimating the proportion of vehicle miles that were driven uninsured. But the number of miles of uninsured driving has no connection with how many uninsured vehicles those miles are driven in. Surveys by the California Department of Insurance (Hunstad 1999b) of households that own UVs show that some UVs are driven daily while others are only occasionally driven or are inoperative. The larger proportion of households that own UVs also own IVs compared with the proportion of household with only UVs. Therefore, percent

[10] The author's experience with the effect of premiums and discounts charged as a cost of ownership rather than a cost of miles of car use leads to the prediction that insured cars without the UM option average fewer miles than the large majority with the coverage. Support for this judgment awaits another paper. In any case, any difference in average miles would have a small effect because cars with BIL coverage but without UM coverage are a fairly small minority of all cars with BIL coverage.

of UV miles on-the-road are not at all represented by the UV percent obtained from the difference between the file-record populations of registered and insured vehicles. These file-record UV percents tend to be higher than the UV percents in on-road samples because UVs appear to average significantly fewer miles than IVs.

Ironically, the Utah database results mentioned above indicate that if insurance could be compelled on all cars, the average insurance cost per car would go down. This is because 23% uninsured cars were involved in only 9% of accidents. Although in principle the added risk of being punished for driving an uninsured car would induce more driving caution, the main reason for the under-representation in accidents must be that uninsured cars are driven less, about half as much to judge from the Utah figures. The average mileage of uninsured cars, which includes many zero mileages, must be about half the average mileage of insured cars, which also includes zero mileages. These cars, when insured would bring more premium per car to the insurance pool than annual miles and cost, and therefore would lower the premium for the pool.

In keeping claim costs for driving coverages on a car-year basis, insurers are actually comparing accident-involved populations to file-record populations in the same way that Kuan and Peck (1981) invalidly compared A-I drivers of UVs to all licensed drivers. The entire private passenger automobile insurance system is operated on the basis of file-records of car-years of coverage and claims. The claims for driving coverages, in contrast, represent On-Road random samples of car miles of exposure. To make sense, A-I comparisons must be made by comparing the number of miles pooled that represent the miles of exposure resulting in accidents that are the inevitable consequence of car use. Nonetheless, file records of car owning are the current basis for insurance cost accounting and premiums.

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