Costs and Benefits of Varying Per-Mile Insurance Premiums Based Upon Measured Risks Specific to Each Mile Driven

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Paper Word Count: 7,922
Abstract Word Count: 248

December 4, 2008

[1] The views expressed are not necessarily those of the Federal Highway Administration or the U.S. Department of Transportation.

ABSTRACT

Much has been written about the potential public policy and consumer benefits of pay-as-you-drive-and-you-save (PAYDAYS) insurance, but without acknowledging that the way that PAYDAYS insurance is offered will affect the level of such benefits. Further, actuarial accuracy, consumer acceptance, and the cost of offering PAYDAYS insurance are all affected by how such insurance may be offered. Within the insurance industry, there is substantial ongoing research and experimentation related to identifying the usage-based data that is relevant to driving risk, practical and affordable to collect, and acceptable to consumers to use. The purpose of this paper is to help bring about a better understanding of the costs and benefits of different approaches to offering PAYDAYS insurance. The research discusses the value of using mileage or minutes of travel as an actuarially preferable charging unit to calendar year, and also the added benefits, from the standpoint of further improving actuarial accuracy and also in advancing public policy objectives such as reducing crashes and air pollution, of charging risk-adjusted mileage premiums. The costs of implementing systems to charge risk-adjusted mileage premiums and the consumer acceptance challenges related to tracking driver behavior for such charges are also discussed. As technologies that facilitate tracking become standard in more vehicles or continue to come down in price, and as the relationship between driving factors that may be tracked and claims costs become more apparent in new studies, it is expected that the market will move more toward PAYDAYS premiums with risk-adjusted mileage pricing.

INTRODUCTION

Background

Under PAYDAYS insurance, premiums are charged on a per-mile (or per-minute) basis, so drivers save money by driving less. Traditional rating factors (e.g., residential location, gender, age, and driving record) become subordinate and are incorporated in per-mile rates, which also take into account the specific coverages an individual driver chooses. Through PAYDAYS insurance, companies are likely to more accurately charge their customers based on crash risk and provide policyholders a financial incentive to reduce their driving. By contrast, traditional insurance rates vary quite little based on mileage, even though only a small percentage of insurance claims are made (such as for theft) when a vehicle is not being driven.

Consumers have little opportunity today to save money by driving fewer miles despite the fact that insurance claims are directly related to miles driven. In exchange for reducing fixed insurance costs, many drivers—especially lower income ones—would readily accept new mileage premiums that they control by the amount of driving they choose to do. Driving would be reduced voluntarily through trip consolidation, carpooling, alternative transportation use, and forfeiting of low-value trips. Motorists, of course, will only reduce their driving when the savings offered by PAYDAYS insurance pricing exceeds the value of a particular drive-alone trip to them.

While it is true that not all miles driven by an individual are of equal risk, an individual's claims risk is very closely related to how much he or she drives. Further,

advanced technologies allow for risk-adjusted mileage premiums, meaning that if a mile is driven at a dangerous time, in a dangerous way (perhaps determined by the amount of hard braking that occurs), or even on a dangerous facility, it could be priced higher than a mile of travel that is deemed to be safer. In any event, using miles instead of the calendar year as the principal exposure unit would almost certainly better align premiums with risk, regardless of whether the charge for each mile of travel is adjusted to reflect the claims risk associated with driving that particular mile.

By converting fixed insurance costs to per-mile charges, PAYDAYS insurance encourages voluntary reductions in driving and related decreases in congestion, air pollution, and crashes, and for these reasons has garnered some interest among government entities, environmental and other non-profit organizations, insurance companies, and consumers. The benefits to the public of allowing drivers, through PAYDAYS premiums, to share in the savings from reduced insurance claims resulting from their driving less have been well documented. Studies estimate between an 8 and 20% reduction in vehicle-miles traveled (VMT) would result if all fixed automotive insurance costs were converted to usage-based (1)(2)(3)(4). Further, there would be a crash reduction rate of 1.34 times the reduced VMT accounting for multiple-vehicle crashes that would not have occurred had one of the vehicles involved been off the road (5). (The projected driving reductions include those of currently uninsured drivers who choose to purchase PAYDAYS policies because of their affordability and then reduce their driving because of the per-mile charges. Some small increases in driving might also occur from law abiding individuals who, because they could not afford to purchase traditional insurance policies, chose not to drive, but who could afford PAYDAYS premiums for high priority trips.)

The Federal Highway Administration models estimate typical infrastructure improvements savings of 3 to 5¢ for every mile not driven (5). The Brookings Institution has calculated that between $50 and $60 billion in net social benefits from reduced driving related externalities would result in the U.S. if PAYDAYS premiums became the standard insurance product offering. The Brookings Institution has also projected that 63.5% of households would save an average of 28% on their total premiums (including the portion of premiums providing comprehensive coverage, which was assumed not to vary by mileage), or about $496 annually for the households that do save (1).

Most major car insurance companies in the U.S. are experimenting with technologies that would facilitate their offering PAYDAYS insurance if they someday choose to and a subset of these companies is seriously contemplating offering it in the near term, at least on a pilot basis. Those outside of the insurance industry that are interested in promoting PAYDAYS insurance often lack an appreciation for the challenges that companies face in offering it. These include costs to install in-vehicle technologies, burdensome state regulatory filing requirements, hard to appraise policy-loss and premium-revenue risks, and substantial work to retool their internal billing and customer communications systems. Despite these challenges, companies have competitive reasons to offer PAYDAYS insurance products, such as appealing to low-mileage and lower-risk teenage drivers who could enjoy substantial premium savings, and also to defend market share if other companies offer such products.

Issues that companies need to consider when selecting amongst the many possible options of PAYD insurance products include costs, ease of implementation, consumer acceptance and market share potential, actuarial accuracy, and impacts on claims. For public relations purposes, companies may also want to consider privacy issues, the relative environmental benefits of different product approaches, and equity issues, such as impacts on low-income drivers. Tradeoffs among these concerns are inevitable—for example, it is likely that the more that is tracked, the better the actuarial accuracy, the higher the cost, the larger the concern about privacy, and the greater the safety and environmental benefits will be, assuming drivers accept the product.

Historical Underpinnings for Risk-Adjusted PAYDAYS Insurance

There is a substantial history of contemplation of PAYDAYS insurance pricing, including not just mileage, but also other usage variables. A paper presented at a 1930 Casualty Actuary Society meeting identified the following hazards as worthy of being incorporated into ratings: "1. The car—age, condition, etc.; 2. Highways—road beds, curves, visibility, etc.; 3. Traffic density; 4. Laws, regulations, and their enforcement; 5. Efficiency of driver—age, experience, habits, impairments, etc.; 6. Mileage; 7. Speed; 8. Weather conditions; 9. Seasonal use of car; and 10. Day and/or night use of car." The author was not sure how precisely any of these factors should be weighted, but he acknowledged that they were likely not independent of each other. While recognizing the limitations of and practical barriers to using each, he identified "conceivable exposure media…[that] might be considered: 1. Car-Year; 2. Mileage; 3 Car-Hour; 4. Fuel-Consumption; and 5. Payroll." While in 1930 he could not even conceive of the possibility of charging based upon real-time driver behaviors and roadway conditions, he nevertheless explicitly identified them as worthy of consideration for premium setting (6).

An article published in 1968 by Economics' Nobel Laureate William Vickrey explained why it would be advantageous to base insurance premiums upon exposure (mileage and risk) even though the means to do so at the time were not available. "[T]here is in addition the frequently overlooked fact that the manner in which premiums are computed and paid fails miserably to bring home to the automobile user the costs he imposes in a manner that will appropriately influence his decision…[T]he added exposure to risk involved in added usage is not brought to bear on the decision." Vickrey acknowledged the importance of distinguishing between "driving a car via route A, or driving via route B – and…whether one is going to drive carefully or absent-mindedly or even recklessly." At the time, Vickrey saw driving distance as at least theoretically observable, but could not foresee today's technologies that would make driver behaviors readily observable as well. Vickrey was explicit about the desirability of charging drivers based not only on distance driven, but also on route selection: "For four-lane freeways as a whole, the marginal accident rated is 1.46 times the average accident rate; for six-lane freeways the ratio is 1.51 and for eight-lane freeways 1.60." (7)

In 1968, reversing odometers was common and legal, and while Vickrey foresaw that "the development of more tamper-proof odometers might in time make…[charging per mile

for insurance] practical," he thought that tying insurance premiums to the sale of tires or gasoline was a more practical option then. Under either of these alternative charging schemes, Vickrey explicitly noted the benefit of effectively charging more for higher speeds, which uses more fuel and causes greater tire wear, because of the related increased crash risk. Neither solution was perfect in Vickrey's mind though. "The main serious defect in the insured tire concept…is that it would not permit adequate geographical variation in the rates: there would be no way of preventing tires purchased in a rural low-risk area being used predominantly in a congested high-risk area." In summary, Vickrey's ideal charging scheme, made clear by his 1968 article, would be based on mileage and adjusted for risks associated with route choice, level of congestion, driver speed, and driver care. While there was no practical way to implement anything like this in 1968, Vickrey nevertheless presented a strong case as to why such a scheme would be desirable and what specific alternatives he believed were practical at that time (7).

CRITICAL ISSUES

PAYDAYS Product and System Choices, Costs, and Known Claims Impacts

PAYDAYS pricing requires verified mileage data, which can be acquired in various ways. The simplest approach is to have brokers or vehicle owners report odometer readings over the Internet or by mail, with random spot checks for verification. More sophisticated systems use electronic devices which automatically collect and send mileage data and, in some cases, even track when and approximately where a vehicle is driven to allow risk-adjusted mileage premiums to be assessed. The cost of automated data collection is declining since most new cars have odometer data recorded on internal computers. When coupled with wireless communication systems, this data has sometimes been, with the consent of the vehicle owner, automatically shared with auto dealers who in turn use it to alert such owners of servicing needs. The same data could also be shared with car insurance companies, again with owner consent.

If the only vehicle usage data sought is mileage, then there are a variety of inexpensive ways available to acquire it. One researcher, Todd Litman, has long advocated certified odometer audit programs, which he estimates would cost only between $5 and $10 per year per vehicle to secure accurate mileage data (2). Such audits would likely be preformed under contract with major oil change establishments. MileMeter, a start-up insurance company that plans to charge per mile of insurance coverage rather than per year or part thereof, has figured that it does not need to monitor mileage at all, but would only need to confirm mileage when a claim is filed to determine if the vehicle is insured at that time (e.g., if 2,000 miles of coverage between 86,567 and 88,567 miles had been purchased, a claim will be honored so long as vehicle mileage falls within this range). The Hollard Insurance Company has begun to offer a product like this in Australia (8).

Many states annually read and record mileage from vehicle odometers as part of their mandatory inspection and maintenance programs. Massachusetts is among the states that does this and since April of 2008 the Boston-based Plymouth Rock Assurance Company (PRAC) has begun to use this mileage data in rate setting. Customers are

categorized into one of 144 cohort groups (which considers household location, vehicle usage and household composition) and are then further classified based on how their verified annual mileage compares to others within their group (i.e., low, average, high, or unknown mileage). PRAC's actuarial data justifies sizable rate changes based on mileage classification, including discounts for drivers in the low-mileage category within a cohort group of up to 40%. Offering such a large discount especially to new low-mileage customers could provide PRAC a tremendous marketing advantage over its competitors. PRAC further found that higher-mileage drivers could have a 10% increased claims risk, and drivers of vehicles without verified mileage also are greater claims risks. While raising prices to reflect such increased risk could cost PRAC some customers, the losses would be of customers who likely were not profitable to PRAC (9).

Beyond state-level and private (e.g., CARFAX) sources of mileage data linked to specific vehicles, many vehicles already have equipment installed in them that can be used to collect and communicate usage-based data, and many more vehicles will be so equipped in the future. For example, OnStar has over 5 million subscribers in the U.S., and a year of coverage is standard on every GM vehicle. OnStar can easily and inexpensively communicate mileage data, and indeed is doing just that for GMAC Insurance customers enrolled in the company's low-mileage insurance discount program (which, for example, provides discounts of 54% for the lowest-mileage drivers, driving 2,500 or fewer miles per year, and 13% for those driving between 12,501 and 15,000 per year) (10). (In addition to OnStar offering verified mileage data, company executives assert that its customers experience claims losses that are 10 to 15% less than noncustomers because they are more safety conscious (11).)

The costs of after-market in-vehicle monitoring technologies are coming down rapidly and many vendors, while willing to provide ballpark estimates, are reluctant to publicize prices instead preferring to negotiate deals with individual insurance companies. It makes sense for insurance companies to base their technology choices not on current prices, even if pilot projects or product roll-out is beginning now, but rather on anticipated near-term or even middle-term future prices, since those prices are what they will actually be paying when most of their customers who choose a PAYDAYS premium product will begin to enroll in such a program.

Companies are expected to refine their pricing models as they collect more usage data and draw correlations with their own loss costs. Many companies may not be entirely confident about what data they will want to collect in the future as they are not now sure of the actual actuarial value of each prospective data element. As a result, companies today will likely choose to use technologies that allow them to collect a substantial variety of usage data, even if some elements of the data collected are not initially, and ultimately may never be, used for rate setting. Companies also have the option of using data that is collected and analyzed by others to supplement or substitute for collecting their own data. Vendors of systems that facilitate or enable PAYDAYS pricing have a big incentive to provide persuasive evidence to insurance companies that the data that their systems collect are invaluable for PAYDAYS premium rate setting. The National Highway Traffic Safety Administration (NHTSA) is supporting naturalistic instrumented-vehicle studies,

measuring many physical parameters related to vehicle operation and also videotaping drivers and the road, where a variety of driver behaviors are correlated with observed crashes and near crashes (12).

Even the highest-priced data collection systems are becoming more affordable, at least when compared to their benefits in certain market segments. For example, DriveCam's system, which includes monitoring vehicle use for physical triggers that are correlated with crashing, such as hard braking and abrupt steering, and videotaping drivers and the road, estimates a full-system cost, which includes data reports and analysis around trigger events, at about $1,000 per vehicle for three years. For families with new teenage drivers, American Family Insurance is offering to install this system for free, and is additionally providing bonuses to agents and 10% discounts to the teen portion of policies written in Minnesota and Colorado. DriveCam asserts that its system, which includes detailed driver reports and parental coaching, reduces teen physical triggering events by 60% in three weeks, with continued more modest declines thereafter. (Note that teenage driving improves on its own over time, but certainly not this quickly.) DriveCam also provides evidence that crashes are reduced by over 50% and, even subtracting costs, the system saves insurance companies over $500 per teen driver per year. While the American Family Insurance partnership is not offering a PAYDAYS product (indeed, American Family neither wants nor receives any data reports or video footage), the technology could certainly be used for such a product (13).

Another technology that is typically used to rate drivers but not for PAYDAYS premiums (although, like with DriveCam, it could be) is IVOX. Similar to DriveCAM, IVOX collects second-by-second global positioning system (GPS) and accelerometer data and records windshield wiper use. Real-time vehicle speeds are compared to speed limits. Vehicle speed and sideways gravitational-force data are combined to show incidences of high rollover risk and reports are shared with the client company to coach drivers and ultimately to make employee retention decisions. While IVOX's primary market is serving truck and other vehicle fleets, the company is marketing to the "best of the worst" in the non-standard personal lines insurance market. Regarding the cost of monitoring units, IVOX reported it to be $183 in April of 2008, with a goal of coming down to about $100 sometime in 2009. According to IVOX, a 45% reduction in claims costs has been realized by its commercial clients (14).

At the other end of the technology spectrum is a simple product offered by Shamir Systems, an Israeli company. Sharmir's PayGo system uses in-vehicle units that record only the amount of time and time-of-day that a vehicle is in motion. The units are thought to be inexpensive, although the company has not publicly announced its prices. Sharmir Systems can generate vehicle-usage reports for insurance company customers (15).

No discussion of PAYDAYS insurance is complete without acknowledging the extensive efforts of Progressive Insurance. Progressive started its foray into PAYDAYS insurance by offering its genuine usage-based premium using a number of vehicle parameters, including vehicle location as tracked by GPS. Progressive's "Autograph" pilot took place in Texas, and lasted from 1998 to 2001. Beginning in 2004, Progressive began

its TripSense Program in Minnesota, Michigan, and Oregon. TripSense collected data exclusively from vehicle on-board diagnostic systems (which did not record driving location). TripSense allowed participants to review data from their vehicles on their home computers and, at their discretion, share it with Progressive for an appropriate discount. Progressive's newest program, MyRate, is the next generation of TripSense, providing cellular communication of the on-board diagnostic data from the vehicle to Progressive, expanding to more states, and affecting premiums more substantially. That is, while drivers could earn discounts of up to 25% under TripSense, with MyRate, depending upon state regulations, discounts of up to 60% and surcharges of up to 9% may be applied (16). Units like those being used by Progressive have previously been estimated to cost about $100 each, although Progressive might be paying less.

Outside of the U.S., Norwich Union, the United Kingdom's largest insurer, announced in 2004 its intention to create an actuarially accurate PAYDAYS pricing scheme by spending up to two years gathering data from 5,000 customer volunteers who installed "black box" telematics devices in their vehicles. Norwich Union ended up offering two usage-based products in the marketplace, but they were both discontinued in June 2008.

The pricing adopted by Norwich Union prior to its discontinuance is instructive in terms of what it says is known about the actuarial underpinnings of PAYDAYS insurance. This is because a good deal of usage-based data were collected beforehand that were likely matched with Norwich Union's extensive, preexisting claims data to set rates. The company published a sample rate table for drivers between the ages of 24 and 70 that converted a 350 pound annual premium to a fixed 11 pound monthly charge (132 pounds per year), plus a usage-based charge. A higher peak-rate—up to 1.8 times the off-peak rate—applied between midnight and 5 AM (which makes sense since drivers in all demographic groups experience increased risks during late-night driving), and again from 7 AM to 10 AM. There was no afternoon peak surcharge, which is surprising because drivers are often tired and it is typically dark in the winter months when driving home. A much larger variability in rates—up to 8.2 times—depended on the road type being used. The per-mile charge for the sample driver varied by 11.4 times, when incorporating both roadway type and time of trip. (The peak-time sample rate varied from 0.57 pence for a "motorway," the safest facility type, to 4.68 pence for roadways with "20/30/40 speed limits," the most dangerous facility type. The costs to use these roadways during off-peak times were 0.41 and 2.74 pence, respectively.) (17).

In contrast to with older drivers, Norwich Union made no road-type distinctions when setting mileage charges for its PAYDAYS product designed for drivers between the ages of 18 and 23. Perhaps this was done so as not to distract from communicating the key pricing message to this demographic group—avoid driving during the especially-dangerous-for-young-drivers 11 PM to 6 AM period or else pay a steep one pound per-mile charge when driving during those hours (versus the normal per-mile sample price of 3.39 pence, charged after the first free 100 miles in a month are used up, which is in addition to the fixed monthly premium of 24.38 pounds) (17).

Interestingly, Progressive Insurance, which provided technical support to Norwich Union, is pursuing a very different pricing model in the U.S. While, as noted above, Norwich Union's pricing varied quite substantially (i.e., by a factor of 8.2) based upon the road type that a driver traveled on, Progressive is not using GPS and thus cannot determine what road type a driver is using or vary per-mile prices according to road-type related risk. It is possible that road type is a less important determinant of claims costs in the U.S. than it is in the U.K, especially as the U.K. is known for having some narrow, curvy, and dangerous roads with low-posted speed limits which are far less common in the U.S. Nevertheless, the price difference among the road types is so great in the U.K. that, even if the difference in risk were only half as great in the U.S., it would still be quite substantial. This suggests that if an insurance company, either by choice or because it is prohibited by a state, does not use driving location as a rating variable for determining a PAYDAYS premium, it might be better off rating on minutes of driving (such as through the product offered by Shamir Systems) rather than mileage to reflect the much higher per-mile claims risk on lower-speed roadways suggested by Norwich Union's pricing.

To illustrate why, assume that the actuarially justified rate differential based on road type is half in the U.S. what it is in the U.K. Also assume that a driver on the lowest speed road, with "20/30/40 speed limits" (and an average driving speed of 30 mph), travels about half the distance of a driver on a "motorway" or freeway (with a 60 mph average speed) over a unit of time. Rather than risks varying by a factor of 8.2 during peak times and 6.7 during off-peak times, as reported for the U.K. above, we assume here half the variability in the U.S., or 4.2 times peak and 3.85 times off-peak variability. Since the average speed on the least safe road type is half that of the safest road type, and since without GPS it would be difficult to ascertain where a motorist is traveling, charging per minute instead of per mile would reduce these differentials by half again, to 2.1 times and 1.9 times, respectively. Thus, charging per minute, at least under these assumptions and when not accounting for road type, would be substantially more actuarially accurate than charging per mile. Of course, per-minute pricing would also have the effect of charging motorists who are stuck in freeway traffic more, but this, too, might be justified as there are other data that show that stop-and-go freeway traffic is more likely to lead to crashes than free-flowing freeway traffic. On the downside, per-minute pricing could encourage speeding, although there was no evidence of this when Progressive charged by minute with its Autograph PAYDAYS product, and monitoring of other speed-related variables, such as hard braking, might eliminate such an incentive.

Consumer Acceptance

Although its size may be difficult to discern, there is clearly a market for PAYDAY insurance in general. To demonstrate, the Environmental Defense Fund gathered over 15,000 nationwide pledges and the Oregon Environmental Council (OEC) secured an

additional 1,200 pledges from Oregonians to purchase PAYDAYS insurance if available and competitively priced.

Consumers vary widely on the question of how much monitoring they would accept on the part of their insurance provider in order to secure lower premiums. The failure of Norwich Union's PAYDAYS product, where press reports said that the company only succeeded at securing fewer than 10,000 customers versus the 100,000 that had been sought, suggests some limitations, but how much that failure had to do with company's product design (which included all sorts of telematics services), marketing, consumer lack of interest in PAYDAYS insurance itself, or consumer reluctance to accept the specifics of the monitoring required by Norwich Union (including the vehicle's location) is not known, at least publicly.

Interestingly, Progressive Insurance announced its substantially increased commitment to PAYDAYS insurance, through its new MyRate program, at about the same time that Norwich Union pulled its product from the market. Progressive said that with TripSense, the predecessor program to MyRate which had been available in Michigan, Minnesota, and Oregon, 34% of its customers who signed up for insurance in those states by telephone and the Internet chose TripSense over Progressive's standard product. Progressive reported interest among over half its customers for PAYDAYS policies, so long as they can save money (18).

GMAC Insurance claimed higher customer retention rates among those enrolled in its low-mileage discount partnership program with OnStar (19). DriveCam surveys showed that 83% of participating teenage drivers would recommend the program to friends and classmates, although in a strict sense, it is not offering a PAYDAYS insurance product (13).

The issue of consumer acceptance may affect what state governments will and will not allow for insurance pricing. For example, while California's AB2800, explicitly allowing PAYDAYS premiums with mileage verification, passed the state assembly by a whopping 72-2, Insurance Commissioner Steve Poizner, a vocal supporter of mileage pricing, said that while he is supportive of allowing various usage-based pricing criteria in rate setting, he draws the line at those requiring GPS—"This creates too many privacy problems. I don't support at all the tracking of the exact locations of where drivers are going, period." This is despite the fact that systems using GPS can be designed to protect privacy (20).

Actuarial Accuracy & Usage Data—What Recent Instrumented Vehicle Studies Say

While existing usage-based data sources have their limitations, taken together a clear picture emerges that incorporating usage data beyond just mileage would be enormously beneficial to the actuarial accuracy of PAYDAYS pricing. (Even without such data,

however, PAYDAYS pricing that relies solely on miles or minutes of travel is expected to substantially increase the actuarial accuracy of insurance pricing.)

The most important study to date to inform the consideration of risk-adjusted PAYDAYS insurance pricing was the 100-car naturalistic study conducted by the Virginia Tech Transportation Institute with support from NHTSA. Usage data across many parameters were collected and video was recorded so that the safety-related significance of trigger events (e.g., hard braking or particularly jolting turns) could be discerned. This study recorded 82 crashes (of which there were complete data for 69 of them), 761 near crashes (defined as a circumstance requiring a rapid, evasive maneuver approaching the limit of the vehicle's capability), and 8,295 incidences (defined as requiring a crash-avoidance response that is more severe than a "normal" maneuver to avoid a crash). Of the 69 crashes with sufficient data, only 12 were reported to the police, and in a follow-up the researchers said that they did not know how many were reported to the insurance company. If we assume that that number is the same as police-reported crashes, 12, this would represent only a tiny fraction of the total crashes, near-crashes and incidences. The study found that the driver behaviors that immediately preceded crashes and near crashes were similar, thereby allowing the two to be treated the same for statistical purposes. Thus, a study like this, because of its recording of so many relevant safety events, requires only a small fraction of the usage data that an insurance company might otherwise need to establish risk-adjusted mileage premiums (21).

Odds ratios from a logistic regression model were used in the naturalistic study to compare the baseline probability of certain driver behaviors with the probably of observing such behaviors immediately preceding a crash or near crash. Inappropriate passing (which requires video to observe) was over represented in crashes and near crashes by 72 times, versus about three times for drowsiness and inappropriate speed. Interestingly, only about half of the time did "inappropriate speed" reflect exceeding the posted speed limit; in the other half of cases, this referred to driving too fast for conditions. Thus in half the speed related events, video is needed to confirm the risk. (Many drivers would likely object to their personally being monitored by video, but more might accept it if cameras were only pointed at the roadway and not the inside of the car.) (21)

Regarding mileage, 26.6% of participants in the 100-car naturalistic study drove 9,000 or fewer miles annually, while 19.2% drove over 18,000 miles. Despite inquiring, data from this study were not readily available about whether the lowest- and highest-mileage drivers differed in the riskiness of their driving. In another, albeit smaller instrumented vehicle study that took place in Israel and is discussed below, no difference in per-mile risk was detected between low- and high-mileage drivers. The 100-car naturalistic study found an over 100-fold difference in the combined number of per-mile incidences, near crashes, and crashes between the 12.5% of the most dangerous drivers and the 12.5% of the safest drivers (219.5 v. 2.1 per 10,000 miles driven). Thus, while it would be of value to insurance companies to receive verified vehicle mileage data to discern exposure to risk, it would seem to be of great additional benefit to them to learn how safely each of their customers drives for the purpose of establishing the per-mile premium rate (21).

One study in Israel placed event data recorders in 103 employer-owned vehicles (which are especially common in Israel) and compared driving habits to past insurance claims. Monitors were first put in vehicles without instructions (although, by law, drivers were told about them). Based upon the data that was gathered, drivers were then classified into three categories: green (good)—39 drivers, yellow (intermediate)—41 drivers, and red (aggressive)—23 drivers. While there were no significant differences in driver mileage among the groups, there were huge differences in the at-fault crash rates and at-fault crash costs. The respective annual rates were 0.09, 0.14, and 0.49 and costs were 194, 374, and 3219. Thus, the least-safe drivers (red) were responsible for 16.6 times and 8.6 times the crash costs as the safest drivers (green) and average drivers (yellow), respectively. Given, again, that usage patterns among the groups did not significantly differ, it shows that an insurance company could benefit greatly if it learned who the worst drivers were and either charged them appropriately or stopped covering them. Exposing the drivers to the data (who knew that their employers were also seeing it) led to a 38% reduction in at-fault crashes without reduced mileage. The greatest total and percentage declines in the driver-risk index occurred amongst the least-safe drivers (22).

Another study, relying on usage data from 460 instrumented vehicles in Atlanta, highlighted the differences between drivers who were and were not involved in crashes. Crash-involved drivers drove 36% more freeway miles, especially during the morning commute period (54% more), drove at higher speeds on all facility types and at all times, and had significantly more hard deceleration events (defined as decelerating at 6 mph per second or more) (23).

A Swedish study showed that a financial incentive for not speeding cut the rate of speeding by about half (24). A similar study for young drivers that took place in Denmark, where drivers were provided a 30% insurance discount for participating, but lost some of that discount every time they sped and were alerted by an in-vehicle unit when they were speeding, also showed reduced speeding (25).

In addition to the studies cited above which are available in the public arena, many companies have, on an experimental basis, persuaded some of their customers to allow the installation of in-vehicle data collection technologies for gathering information about customer interface and usage-based driving risk that will eventually enable them to move to PAYDAYS pricing if they so choose. Typically in these cases, only the individual insurance companies, and perhaps also their actuarial consultants, will be able to discern usage-base risk from this data because companies generally closely guard their loss-cost data (except when state insurance regulators require that they be shared and, in some cases, also be made public in some form in order to justify premium pricing).

Reducing Insurance Claims

Reduced participant claims costs is a major reason that PAYDAYS insurance can both save consumers money and lead to higher insurance company profits. (The other big reason is market segmentation, since monitoring allows insurance companies to find low-mileage drivers that they otherwise could not find and offer them an especially attractive rate to reflect their reduced claims risk and also to appropriately price unprofitable high-mileage drivers to encourage them to change carriers or drive less.) An especially impressive result that has been reported is that Norwich Union's usage-based pricing led to a reduction in claims of over 30% (26).

For assessing claims cost changes, one needs to know, or at a minimum be able to estimate, both per-driver crash-claims reductions resulting from switching to PAYDAYS insurance and market penetration of the specific PAYDAYS insurance product being examined. Regarding per-driver claims reductions, this would result from reduced VMT for straight-mileage premiums and both reduced VMT and safer driving for risk-adjusted mileage premiums (whether directly from improved driving or indirectly by drivers avoiding the riskiest drive times and, perhaps routes, that result in the highest per-mile prices to them).

On-going research in the field of "mental accounting"—a discipline combining economics and psychology to explain consumer decision making—strongly suggests that varying features of the PAYDAYS insurance product would result in differing impacts on VMT. This research suggests that ideally PAYDAYS insurance would entail direct mileage charges and frequent billing, and customers would be regularly reminded of mileage costs, such as through in-vehicle taxi-like meters. PAYDAYS insurance would even be complemented with discounted transit passes and customers would be provided with individualized assistance to reduce mileage, including identifying alternative transportation, trip consolidation, and trip elimination (e.g., through Internet shopping) options (27).

Public Policy Considerations

The most important point to reiterate is that the public policy benefits of genuine PAYDAYS insurance, regardless of whether per-mile or per-minute premiums are risk-adjusted, are potentially significant. These benefits are discussed briefly in this document, but only the differences between the benefits of straight versus risk-adjusted PAYDAYS premiums are considered extensively here.

Throughout the environmental literature, "calm" driving has been reported to substantially improve fuel economy and reduce vehicle emissions. Slower driving, especially on freeways, also yields substantial fuel economy and air quality benefits. These added benefits will only be realized if premiums are risk-adjusted to incorporate speed and driver aggression.

Risk-adjusted premiums can have important effects on equity. If GPS is used and pricing is based upon where driving occurs rather than where someone lives, that could be enormously beneficial to residents of poor inner cities who today face especially high annual insurance premiums because of household location. Some technologies, however, cannot be installed in old vehicles, which are more common in the inner cities than elsewhere (although this seems to become less of a problem over time, because on board diagnostics are available on post-1996 cars and more and more cars that are older than that are being retired each year). For night-time shift workers who can prove their employment, consideration for reduced late-night cost premiums for trips directly between home and work should be considered.

One of the biggest potential benefits of risk-adjusted premiums is that since some driving is much more dangerous than other driving, aligning prices with risks will lead to reductions in crashes that are disproportionate to mileage reductions. In addition to the obvious benefits to personal well being and to personal and insurance company finances, crashes are responsible for about half of the congestion in the U.S. and also the resulting extra emissions from stop-and-go driving near crash sites.

When considering almost all public policy concerns, except for privacy, risk-adjusted mileage pricing is generally preferable to straight per-mile or per-minute PAYDAYS pricing. The big caveat, though, is that it is not the concept of PAYDAYS pricing, but rather its implementation, that provides public benefits. If the cost of implementing risk-adjusted PAYDAYS premiums or consumer acceptance challenges related to it means a substantially lower market share than if straight per-mile or per-minute PAYDAYS pricing were implemented instead, pursuing risk-adjusted premiums would harm public policy objectives. It is for this reason that one researcher, Todd Litman, argues for straight mileage pricing. He estimates that if monitoring devices continue to cost around $150 each, then risk-adjusted premiums would only make economic sense for those driving fewer than 9,000 miles per year (28).

DISCUSSION

There are two different insurance-related purposes for collecting usage-based driving data. The first is to alert drivers and in some cases others (e.g., parents of teenagers or supervisors of professional fleet-vehicle drivers) about what the safety implications of their driving habits are. In exchange for agreeing to monitor driving and to implement procedures to encourage safer driving, such as through parental or fleet-supervisor coaching, flat insurance discounts may be available. The second purpose is to implement PAYDAYS insurance.

The two general models for implementing PAYDAYS insurance pricing is to use only mileage or minutes-of-driving data or to also collect additional usage-data for risk-adjusted per-mile or per-minute PAYDAYS premiums. In pricing PAYDAYS insurance to incorporate additional usage-based risk, the pricing serves the dual purpose of teaching drivers about risk and providing ongoing financial incentives to reduce it.

One possible model of pricing would be to separate out the collection of data related to driving characteristics from straight mileage or minutes-of-driving data. An insurance company could assume a driver to be of average risk within his cohort group and charge a pre-set per-mile premium reflective of this, thus facilitating budgeting and ensuring no surprises in terms of what premiums will be owed for taking a particular trip. Then by demonstrating through vehicle monitoring over a specified period of time that he is safer (or less safe) than average, the customer's per-mile premium could be adjusted, going forward, to reflect this.

Alternatively, for some customers, an insurance company might not ask for the driving characteristics data at all so long as it is assured that it is being used, by a parent or company supervisor, to coach drivers to be safer. This is what is occurring with American Family Insurance, which is paying to equip the vehicles of new teenage drivers with DriveCam, having DriveCam share this data with parents but not with American Family Insurance, and providing a flat insurance discount. An insurance company seeking to serve the teenage market might pursue a similar arrangement with DriveCam or another vendor, while having the vendor share just the mileage and time-of-driving data with the insurance company (along with sharing additional data only with the parent) to use as Norwich Union had used for its PAYDAYS pricing of young drivers and GMAC Insurance uses for its low-mileage discounts.

CONCLUSIONS

Existing published research suggests that there is actuarial value in using miles or minutes of driving, instead of the calendar year, as the basis for premium charges. Further, characterizing the risk of each unit of travel for individual drivers substantially improves the actuarial accuracy of PAYDAYS insurance pricing. For example, as reported in this research, the PAYDAYS pricing scheme that Norwich Union adopted suggests that the per-mile claims risk for an individual driver varies by 11.4 times depending upon roadway type used and the time the trip is taken. One instrumented vehicle study shows that the least safe driver is 16.6 times more dangerous than the safest driver, while another study suggests that the differential may be over 100 times. Thus, risk-adjusted mileage premiums would be worth charging if an insurance company finds an economical way of acquiring the needed data and using it in a manner that is acceptable to customers. Regardless of whatever decision an insurance company makes about collecting usage-based data beyond mileage, however, evidence supports the actuarial benefits of charging for miles or minutes of travel even if not attempting to differentiate the risk of each unit of travel by an individual driver. Nevertheless, some differentiation may be possible with little additional technology or cost (such as to time stamp each mile or minute of driving) and even such minimal differentiation would be actuarially beneficial.

Ideally, the value of each element of new data collected, in terms of improving actuarial accuracy, would be understood, as would the fixed and ongoing costs of collecting such data and the consumer acceptance level related to such collection. Today's research is not yet there, but we do know enough to begin to see just how valuable some usage-based data beyond just mileage may be in predicting claims risk.

Two future trends suggest that that pricing models will increasing rely on greater amounts of usage-based data and that risk-adjusted premium differentials will continue to increase. First, the usefulness of different types of usage data becomes more apparent with each new study and will become especially apparent as a result of the forthcoming Strategic Highway Research Program study of 2,500 instrumented vehicles that is scheduled to take place over two to three years. This study will include video recordings and data collection across many driving-related parameters beginning in 2009. Second, acquiring data from vehicles gets less expensive all the time, whether through low-cost separate methods such as the Shamir Systems PayGo technology which tracks the amount of time and time-of-day of vehicle movement, or through systems such as OnStar and ATX that are already in many vehicles and will be in still more vehicles over time.

One possible countervailing trend to the collection and use of greater quantities and variety of data is that increasingly sophisticated models may allow claims risks to be ascertained pretty well with more limited data. Perhaps we will learn in the future that by collecting data only on average speed per unit of driving as a surrogate for road-type, miles and the time of day that each is driven, and fuel economy as a surrogate for careful driving, PAYDAYS premium rates could be set that closely correlate with claims costs. Ultimately, it is the task of each company to determine whether or how to use new information about risks related to exposure and driver behavior in developing actuarial models to support PAYDAYS pricing schemes that are competitive and profitable and that improve customer satisfaction, retention, and growth.

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