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Distance-Based Vehicle Insurance Feasibility, Costs and Benefits

Comprehensive Technical Report

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Abstract. Vehicle insurance is a significant portion of total vehicle costs. A typical motorist spends nearly as much on insurance as on fuel. Insurance is generally considered a fixed cost with respect to vehicle use. A motorist who reduces mileage does not usually receive comparable insurance cost savings. Distance-based insurance converts insurance to a variable cost with respect to vehicle travel, so premiums are directly affected by annual mileage. The more you drive the more you pay, and the less you drive the more you save. Distance-based pricing makes vehicle insurance more actuarially accurate (premiums better reflect the claim costs of each vehicle), and can help reduce total insurance costs, vehicle crashes, traffic congestion, facility costs, energy consumption and environmental impacts. This report investigates the feasibility, benefits and costs of implementing distance-based motor vehicle insurance. It compares several distance-based insurance pricing options, and evaluates related concerns and criticisms. The analysis indicates that distance-based pricing is technically and economically feasible, and can provide significant benefits to motorists and society.

Prices and costs in this report are in year 2000 U.S. dollars unless noted otherwise.

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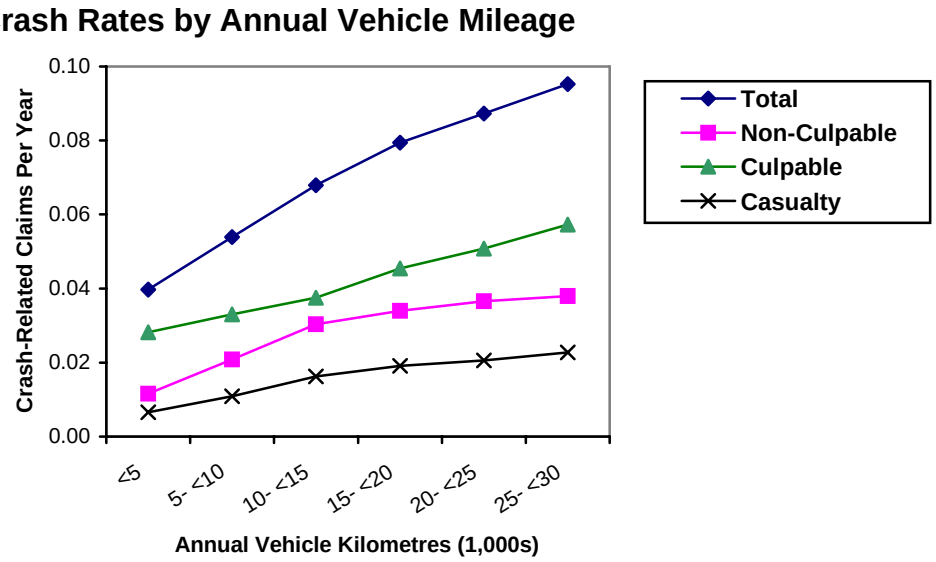
Executive Summary

This study investigates the feasibility, benefits and costs of implementing distance-based motor vehicle insurance. It is based on a literature review, analysis of insurance claim data, comparisons of different distance-based pricing options, and evaluation of concerns that have been raised about distance-based pricing.

Vehicle insurance is a significant portion of total vehicle costs. A typical motorist spends almost as much on insurance as on fuel. Insurance is generally considered a fixed cost with respect to vehicle use. A reduction in mileage does not usually provide a comparable reduction in insurance premiums.

Research described in this report indicates that within existing price categories, annual claims increase with annual vehicle mileage, as illustrated below. Mileage is just one of several factors that affect crash rates. It would not be actuarially accurate to use mileage *instead* of other rating factors, for example, to charge all motorists the same per-mile insurance fee, but actuarial accuracy improves significantly if annual mileage is incorporated *in addition* to existing rate factors. Any other price structure overcharges low-mileage motorists and undercharges high-mileage motorists.



Crashes per vehicle tend to increase with annual mileage.

Distance-based insurance reflects the principle that prices should be based on costs. It gives consumers a new way to save money by returning to individual motorists the insurance cost savings that result when they drive less. Motorists who continue their current mileage would be no worse off on average then they are now (excepting any additional transaction costs), while those who reduce their mileage save money.

Distance-based pricing can help achieve several public policy goals including actuarial accuracy, equity, affordability, road safety, consumer savings and choice. It helps reduce traffic congestion, road and parking facility cost savings, and environmental impacts. It can reduce the need for cross-subsidies currently required to provide “affordable” unlimited-mileage coverage to high-risk drivers.

This study evaluated several distance-based pricing options:

1. *Mileage Rate Factor* (MRF) incorporates an annual mileage rate factor into the existing rate system. It is the easiest option to implement, but is constrained by the weight that can be placed on self-reported mileage estimates. Its travel impacts and benefits are small.

2. *Pay-at-the-Pump* (PATP) funds basic insurance coverage through a surcharge on fuel sales. It is not actuarially accurate because payments are based on vehicle fuel consumption, not risk factors. Less than half of insurance payments would be distance-based, and cross-border and illegal fuel purchases could be major problems. It causes a relatively large reduction in fuel consumption but modest reductions in vehicle travel, providing modest overall benefits. There would probably be little administrative cost savings because motorists would still need to pay registration fees and purchase optional coverage as they do now.

3. *Per-Mile Premiums* changes the unit of exposure from the vehicle-year to the vehicle-mile, incorporating all existing rating factors. It requires odometer audits to provide accurate mileage data, predicted to cost an average of $6 per vehicle year. It could be mandatory or a consumer option. It significantly improves actuarial accuracy and provides significant consumer savings, particularly to lower income households. Because it causes large reductions in vehicle travel it provides large benefits. As a consumer option it is predicted to attract 25-50% of motorists within a few years, and this should increase over time.

4. *Per-Minute Premiums* uses a small electronic meter to record when an engine operates, predicted to cost $30 per year. This allows rates to vary by time of day. Because it can give motorists an extra incentive to reduce their peak-period travel it can provide even greater benefits than Per-Mile Premiums, but the additional equipment costs reduce the net benefits. As a consumer option it is predicted to attract 12-25% of motorists within a few years.

5. *GPS-Based Pricing* uses GPS (Global Positioning System) technology to track vehicle travel, allowing insurance prices to reflect when and where a vehicle is driven in addition to existing rating factors. It is predicted to cost $150 or more per vehicle-year and raises privacy concerns. Installation costs may decline somewhat in the future as more vehicles have factory-equipped GPS transponders. It is most actuarial accurate and can cause the greatest crash reduction per participating vehicle. However, its high equipment costs offset the direct benefits for most consumers. As a consumer option it is predicted to attract 10% or less of total motorists, so total benefits would be modest for the foreseeable future.

The table below compares the travel impacts of these options.

Travel Impacts of Distance-Based Pricing Options

	MRF	**PATP**	**Per-Mile** Mandatory	**Per-Mile** Optional	**Per-Min.** Mandatory	**Per-Min.** Optional	**GPS-Based**
Portion of market affected	100%	90%	100%	50%	100%	25%	10%
Price increase per mile	0.7¢	1.4¢	5.6¢	5.6¢	5.6¢	5.6¢	5.6¢
Reduction per participating veh.	1.0%	5.0%	10%	13%	10%	14%	15%
Total vehicle travel reduction	1.0%	4.5%	10%	3.7%	10%	1.8%	0.8%

Distance-based insurance can provide significant safety benefits. Because most crashes involve multiple vehicles, a reduction in total vehicle mileage produces a proportionally larger reduction in total crash costs, all else being equal. Each 1.0% reduction in vehicle mileage caused by distance-based insurance can reduce total crash costs by 1.4% to 2.0%. Distance-based pricing could reduce total crashes by 15% or more.

Distance-based pricing can help achieve equity objectives. Since annual vehicle mileage tends to increase with income, fixed-price insurance causes lower-income motorists to subsidize the insurance costs of higher-income motorists within their rate class. Distance-based insurance pricing provides overall savings to lower-income motorists, and would allow some low-income households to own a vehicle for basic mobility that they cannot currently afford.

Distance-based pricing lets motorists save money by reducing mileage, an option that is currently unavailable. To illustrate this, consider the situation of somebody who becomes unemployed and so reduces driving by half. With current pricing, they continue paying the same insurance premiums as when they were employed and commuting, although both their income and chances of an insurance claim decline significantly. They may find insurance costs, and therefore vehicle ownership, an extreme financial burden. With distance-based pricing, low-income drivers can minimize their insurance costs by minimizing their driving, while still affording a car for essential trips and future work.

The table below summarizes the implementation costs and effectiveness at achieving various objectives for the seven distance-based pricing options considered in this study.

Summary of Distance-Based Pricing Options

	Implementation Costs	Effectiveness
Mileage Rate Factor	Low	Low
Pay-At-The-Pump	High	Medium
Per-Mile Premiums, Mandatory	Low	High
Per-Mile Premiums, Optional	Low	Medium
Per-Minute Premiums, Mandatory	Medium	High
Per-Minute Premiums, Optional	Medium	Medium
GPS-Based Pricing	High	Low

This table summarizes overall costs and effectiveness at achieving objectives.

This analysis indicates that Mandatory Per-Mile Premiums provides the greatest net benefits due to its relatively low cost and effectiveness at achieving objectives. It would provide direct financial savings to most motorists, and only a small portion (less than one in five) would perceive significantly higher insurance costs. Optional distance-based pricing results in greater direct consumer benefits per participating vehicle, but smaller total benefits due to low market penetration and the low average mileage of motorists who choose it, resulting in relatively small reductions in total vehicle travel.

Distance-based insurance is technically and economically feasible. One insurer has successfully implemented GPS-Based Pricing, the most difficult and expensive distance-based pricing option. Other options should be far easier to implement.

Under some circumstances consumers seem to prefer fixed prices, because it is predictable and minimizes transaction costs. However, this preference appears to be weak. There is no evidence that consumers have a strong preference for fixed-priced insurance. Given the choice, most motorists who expect to save money would probably choose optional distance-based insurance.

There is likely to be strong support for *optional* distance-based insurance pricing since it increases consumer choice and gives motorists a new opportunity to save money. Consumers are accustomed to being able to choose from various rate structures for

many types of goods, such as telephone service, Internet service and air travel. If cross-subsidies are not allowed between the different pricing pools, an increasing portion of motorists would switch to it over time.

There appears to be mixed public support for *mandatory* distance-based insurance. Citizens generally support price reforms that increase fairness and affordability, or help solve specific problems such as traffic congestion and pollution, but are skeptical of changes that may be confusing or less convenient to use, increase costs, or burden particular groups. PATP appears to be the least popular option. Usage-Based Premiums appears to have about equal levels support and opposition, with responses affected by the concept is described. For example, if described as a reward to consumers who use alternative modes, it tends to have a positive response, but if presented as a surcharge on higher-mileage motorists, it tends to have a more negative response.

This study examined various concerns and criticisms raised about distance-based insurance pricing. Many concerns reflect misunderstanding of the concept, and can be addressed with education. Insurers have five legitimate financial concerns about distance-based insurance.

1) It is possible that the mileage foregone will be lower than average risk. As a result, premium revenue could decline more than claim costs.

2) Optional distance-based pricing could attract motorists with relatively high per-mile claim costs.

3) With optional distance-based pricing, motorists in multi-vehicle households could shift driving from vehicles with distance-based to fixed-rate premiums.

4) Total premiums would probably decline, assuming distance-based pricing is successful at reducing claims. Although revenue reductions would be offset by reduced claim costs, this would tend to reduce gross crash flow and investment income, which could reduce insurance company profits.

5) Some motorists may try to steal insurance by odometer fraud. However, odometers are increasingly tamper-resistant, and most types of fraud could be detected during regular checks and crash investigations. Odometer auditing should provide data comparable in accuracy to that used in other common commercial transactions.

Offsetting these risks is the fact that a percentage reduction in mileage usually provides a proportionally greater reduction in claims. A 1% reduction in mileage typically causes a 1.4% to 1.8% reduction in claims, making insurers financially better off. This increases net savings from distance-based pricing and reduces the financial risks to insurers.

Technical concerns can be addressed by implementing distance-based pricing pilot projects to obtain better information on feasibility, costs, consumer demand, travel impacts, crashes, and revenue impacts. This could begin on a relatively small scale, and if no major problems are found it could ramp up until all motorists are offered distance-based pricing.

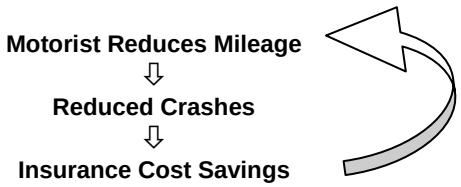
Introduction

When grocery stores price cucumbers by the piece, customers tend to pick the larger ones first. When the same vegetables are priced by weight, smaller cucumbers tend to be picked first. A tender little cucumber may be a good value by the pound but not by the piece. This illustrates how different pricing units can affect consumers' decisions.

This report explores the feasibility of implementing distance-based motor vehicle insurance. Distance-based pricing converts insurance from a fixed cost into a variable cost with respect to vehicle travel. Thus, the more you drive the more you pay, and the less you drive the more you save.

Distance-based insurance is justified on actuarial grounds, since the more a vehicle is driven the greater its chance of having crashes and claims, all else being equal. Under current pricing, when a motorist reduces mileage the resulting insurance cost savings are dispersed among premium payers or retained as profits by their insurer. Individual motorists perceive no direct insurance savings for driving less.

With distance-based pricing insurance cost savings that result when a motorist reduces mileage are returned to that *individual* driver. These are net benefits to society, not just economic transfers.



Distance-based pricing returns to individual motorists the insurance cost savings that result when they drive less. It rewards motorists for reducing mileage and makes premiums more accurately reflect the insurance costs of each individual vehicle.

Distance-based pricing provides a marginal financial incentive to reduce mileage, allowing individual consumers decide which miles, if any, to forego. Any vehicle-miles reduced consist of lower-value vehicle travel that motorists willingly give up in exchange for financial savings, representing a net consumer surplus. Motorists who continue their current mileage are no worse off on average with distance-based pricing (excepting any additional transaction costs), while those who reduce mileage are better off overall. To the degree that motorists reduce mileage, and therefore crashes and insurance claims, the savings that result are net benefits to society, not just economic transfers.

Distance-based insurance pricing can provide many benefits:

- Increased actuarial accuracy. It makes premiums more accurately reflect the insurance costs of an individual vehicle.
- Increased insurance affordability. It offers motorists a new opportunity to save money. Savings could to average $50-100 annually per participating vehicle with some systems.
- It can increase consumer choice. Distance-based pricing can be optional, allowing individual motorists to choose the pricing system that offers them the greatest benefits.
- By reducing vehicle mileage it can reduce congestion, road and parking facility costs, energy consumption and pollution emissions, and provide other benefits.
- It can significantly increase road safety. When motorists reduce their annual mileage they reduce crash risk to themselves and to other road users.
- It is progressive with respect to income. Most lower income motorists should save money, since they tend to drive their vehicles less than average and are relatively price sensitive.
- It reduces the need to rely on cross-subsidies from low-risk motorists to provide "affordable" unlimited-mileage insurance coverage for higher-risk motorists.

There are also barriers and costs associated with distance-based pricing:

- It requires insurers and brokers to change how they calculate premiums, develop new procedures, and modifying computer programs.
- Most distance-based pricing systems increase transaction costs. Incremental costs range from less than $10 to more than $150 per vehicle-year, depending on system.
- It makes premiums and insurance revenues less predictable. Motorists and insurers would not know total premiums until the end of the insurance term.
- It can introduce new financial risks to insurers. It is possible that mileage and premium income would decline more than crashes, or that crash risk may shift to fixed-priced vehicles.
- It increases premiums for some motorists, and may reduce commissions for some brokers.
- It has mixed political support, and there may be opposition from some stakeholders.
- Many people are skeptical of predicted benefits.

What would be the consequences if gasoline were sold like automobile insurance?

With gasoline sold by the car-year, vehicle owners would make one annual advance payment that allows them to pump unlimited amounts of fuel from their company's stations. Prices would be calculated based on the average cost of supplying gasoline to vehicles with similar user profiles.

Unmetered fuel would cause a spiral of increased fuel consumption, mileage, and total vehicle costs, including externalities such as accident risk, congestion, pollution and infrastructure costs. Low mileage (particularly lower income) drivers would simply drop out of the system because their costs per mile would be excessive, leaving them with fewer travel options. Of course, above average fuel users would defend this system because they enjoy benefits.

Such a price system would be irrational. It is comparable to current insurance pricing.

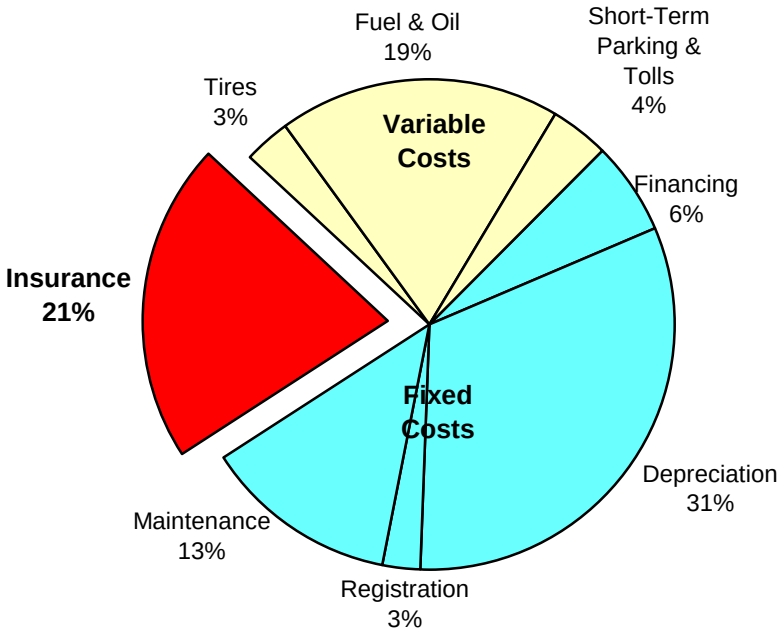
Automobile Pricing Practices and Impacts

This section discusses how distance-based insurance would affect overall vehicle costs.

A. Current Vehicle Insurance Pricing

Figure 1 shows the distribution of motor vehicle expenses. Motorists typically consider only fuel, out-of-pocket parking and toll charges as variable expenses. A portion of vehicle depreciation and most repair costs are also related to mileage over the long term, but they seldom influence individual trip decisions. Premiums per insured vehicle average approximately $850 per vehicle-year in the U.S.,[1] or about $1,360 annually per household.[2] Registration and license fees average about $250 per vehicle-year.

Figure 1 **Typical Costs for Intermediate Size Car[3]**

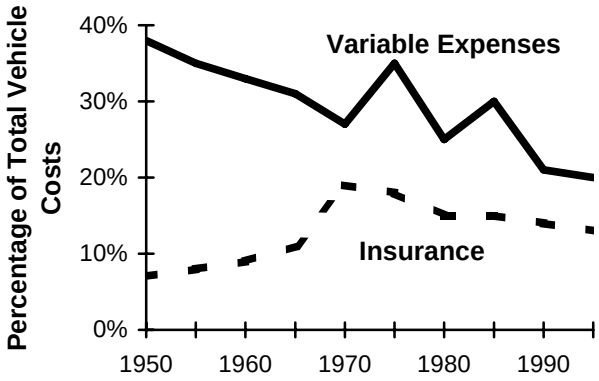


This graph illustrates the major financial costs of an intermediate size automobile averaged over a 12 year operating life.

Although fixed vehicle expenses have increased substantially during the last three decades, variable costs have decreased in real terms. As a result, variable costs as a portion of total costs have declined significantly, as indicated in Figure 2.

Figure 2 **Variable Automobile Costs as a Portion of Total Costs[4]**

[1] For information on current average insurance premiums see the Insurance Information Institute website at www.iii.org/media/facts/statsbyissue/auto.
[2] Assuming an average of 1.6 vehicles per household.
[3] Based on Jack Faucett Associates, *Cost of Owning and Operating Automobiles, Vans & Light Trucks, 1991*, Federal Highway Administration (Washington DC), 1992.



The variable portion of vehicle costs declined from about 40% in 1950 to 20% in 1995.

Insurance actuaries acknowledge that mileage is an important risk factor, but usually give it little weight as a rating factor because self-reported data are unreliable.[5] Instead, less accurate, indirect indicators of mileage are used, such as vehicle type, commute distance, demographic and geographic factors. Insurers consider several objectives besides risk when developing price structures, including administrative convenience, and marketing factors. Prices are often set to attract desirable customers, such as those likely to purchase other insurance (vehicle, home, life, etc.). Regulators often require insurance companies to underprice high-risk drivers for the sake of affordability. As a result, some types of motorists pay far more than their average accident costs, while others pay far less.

Insurance Affordability and Uninsured Driving (Litman, 2004)
Unaffordable insurance is considered a major problem, particularly because it contributes to uninsured driving. Many low-income motorists are forced to drive uninsured, since insurance would cost a significant portion of their net income. This creates a cycle of uninsured driving, uninsured claims and higher premiums in lower-income communities.[6] Higher-income motorists sometimes drive uninsured if they own a vehicle that is only used occasionally. Although most jurisdictions mandate minimum levels of coverage, these requirements are often ignored.[7] But enforcement strategies can be effective. In British Columbia, less than 1% of crashes involve uninsured motorists due to the successful integration of vehicle insurance and licensing transactions. Vehicle owners must pay for insurance to obtain license tabs. This is more effective than simply requiring proof of insurance, which can be evaded with counterfeit documentation.

[4] *Facts and Figures 95*, Motor Vehicle Manufacturers Association, 1995, p. 58.
[5] CAS, *Foundations of Casualty Actuarial Science*, 3rd Edition, Casualty Actuarial Society (Arlington; www.casact.org), 1996, p. 35. Also see p. 242 and 250.
[6] Patrick Butler, *How Per-Car Premiums Induce Adverse Selection and Foster the "High-Risk-Driver" Theory*, presented at the Annual Meeting of the American Risk & Insurance Association, August 2004; available at Cents Per Mile (www.centspermilenow.org).
[7] 12% of 1989 insurance claims involved uninsured vehicles. Tom Wenzel, *Analysis of National Pay-as-you-Drive Insurance Systems and other Variable Driving Charges*, Energy & Environment Division, Lawrence Berkeley Laboratory (Berkeley), July 1995, p. 29.

Factors Influencing Insurance Prices

Insurance is regulated to achieve several objectives, including financial security and responsibility (i.e., to insure that insurance companies will not become bankrupt and cover claims as required), equity and affordability.

In general, insurance prices are intended to be actuarially accurate, meaning that premiums reflect the insurance costs imposed by each policy. This is considered most equitable (consumers pay the costs they impose) and economically efficient (it gives accurate price signals, so consumers have an incentive to reduce risks). However, in practice other factors affect vehicle insurance pricing.

Because most jurisdictions mandate insurance, affordability is a major issue. Cost-based pricing would require some categories of motorists to pay several thousand dollars a year for basic converge, which would make insurance, and therefore legal vehicle ownership, unaffordable to some lower-income drivers. To address this problem, regulators require insurance companies to provide coverage to higher-risk motorists at less than full costs, resulting in subsidies from lower-risk to higher-risk premium payers.[8]

Insurance pricing is also affected by marketing objectives. For example, insurance companies' may underprice automobile insurance attract higher-income consumers who are likely to purchase other types of insurance, such as household coverage.[9] As a result, premiums often overcharge lower-risk motorists (what actuaries call "cream") and undercharge higher-risk motorists. This results in extremely high premiums in lower-income areas, since a greater portion of low-mileage motorists drive uninsured which reduces funds to cross-subsidize higher-mileage motorists.[10] As explained by the National Organization for Women's Insurance Project,[11]

> "Compulsory insurance seems to work in upper-income zip codes where most people can afford to keep insurance on cars driven less than average. Because these cars cost insurers proportionately less in claims, they bring in extra profits and insurers privately call landing their business "skimming the cream." Insurers use extra profits from "cream" customers to compete by holding car insurance prices down for their preferred customers who have many other insurance needs. Customers typically skimmed and overcharged are those who commute by carpool, bus or bicycle, and also women, older people, and households with more cars than drivers. In low income zip codes, insurers redline many cars to higher "nonstandard" prices—not because their drivers are less careful, as insurers encourage everyone to believe—but because of the scarcity of "cream" to hold prices down. What really happens is that miles, costs, and insurance prices (per car) spiral up where high insurance cost and strong enforcement increase the incentive for ever more drivers to share fewer insured cars."

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[8] Caroline McDonald (2000), "Study: Regulation Hikes Insurance Costs for Good Drivers," *National Underwriter* (www.nunews.com), May 10, 2000.
[9] Patrick Butler (1993), "Cost Based Pricing of Individual Automobile Risk Transfer: Car-Mile Exposure Unit Analysis," *Journal of Actuarial Practice*, Vol. 1, No. , pp. 51-84.
[10] Paul M. Ong and Michael A. Stoll (2006), "Redlining or risk? A spatial analysis of auto insurance rates in Los Angeles," *Journal of Policy Analysis and Management*, Vol. 26, Issue 4, Pages 811 - 830; at www.uctc.net/scripts/countdown.pl?842.pdf.
[11] Patrick Butler, *Why The Standard Automobile Insurance Market Breaks Down In Low Income Zip Codes*, Report to the Texas House Committee on Insurance, July, 2000.

How Pricing Affects Vehicle Travel

As discussed earlier, automobile insurance is currently a fixed cost, vehicle owners pay virtually the same premiums regardless of whether they drive 5,000 or 20,000 miles annually. Distance-based pricing converts fixed costs into variable costs. Insurance premiums currently average about $850 per vehicle-year, so distance-based insurance premiums would averaging about 7¢ per vehicle-mile.[12] Vehicle registration and licensing fees, which average about $250 annually, could also be made distance-based. Converting to distance-based insurance would therefore reduce driving about 10%, and 12% if registration and licensing fees were also distance-based, as indicated in Table 1.

Table 1 **Vehicle Travel Reduction From Mileage Fees**[13]

VMT Fee	Change in VMT	VMT Fee	Change in VMT
1¢	-1.6	6¢	-8.7
2¢	-3.1	7¢	-10.0
3¢	-4.6	8¢	-11.2
4¢	-6.0	9¢	-12.4
5¢	-7.4	10¢	-13.6

This table shows predicted vehicle travel reductions from distance-based fees (2005 US Dollars).

Here is an illustration of this price structure. Imagine that you are an average motorist who currently pays $850 for insurance and drives 12,000 annual miles. Now, image that you shift to distance-based insurance and pay 7¢ per mile. If you continued driving 12,000 annual mileage you would experience no change: your annual premium would be the same, but if you find ways to reduce your mileage you would be able to save money. Experience with similar price incentives suggests that given such financial incentives a typical motorist would reduce their mileage by 10%, and so save about $85 annually. The reduced travel represents lower-value miles that you willingly give up in exchange for financial savings.

Distance-based pricing could increase vehicle ownership by about 1%, since it makes owning a low-mileage vehicle more affordable. However, this impact should be modest in North America, since vehicle ownership is near saturation, and would consist primarily of second vehicles, such as a recreational vehicle or collector car. These would primarily substitute for, rather than add to, existing travel. Only a small number of additional cars would actually increase drivers' access to a vehicle, and these would be used significantly less than average, otherwise they would be no more affordable than with current pricing. As a result, the increase in mileage from additional vehicle ownership is expected to be overwhelmed by reductions in travel among existing vehicles.

[12] For information on current average insurance premiums see the Insurance Information Institute website at www.iii.org/media/facts/statsbyissue/auto.

[13] USEPA, *Technical Methods for Analyzing Pricing Measures to Reduce Transportation Emissions*, USEPA #231R98006 (www.epa.gov/clariton) 1998, Table B21, adjusted for 45% inflation 1991 to 2005.

Relationship Between Mileage and Crash Costs

This section examines relationships between vehicle travel, crashes, and insurance claim costs.

A. Crash and Claim Rates

Road risk is measured in several different ways. Traffic safety studies measure *crashes* (also called *incidents*, *accidents* or *collisions*), *injuries* and *fatalities* (injuries and fatalities together are called *casualties*). Crash statistics may reflect either *reported* crashes or estimates of *total crashes* (by multiplying reported crashes by some estimate of the portion of crashes that are unreported).[14] Insurance actuaries measure *claims* and *claim costs* (which includes crash compensation and associated administrative expenses). Less than half of all vehicle-insurance claims are crash-related; glass damage, fire, theft and vandalism do not usually involve a crash.

Crash costs refer to damages and other losses caused by collisions.[15] Society is concerned with total crash costs, which tend to be larger than insurance claim costs since a portion of crashes are uncompensated.[16] For this reason, society has a greater interest in reducing crashes and casualties than private insurance companies, which have no incentive to reduce crashes if they do not capture the financial savings.

Table 2 summarizes typical vehicle crash and claim frequency. Crashes are relatively infrequent events. A vehicle has a 15% chance of an insurance claim each year and only half of those involve a crash. A vehicle is likely to be involved in a crash-related claim approximately once every 14 years or quarter-million kilometres of travel, and a driver is likely to be found culpable (at fault) in only about half of the crashes they are involved in, or about once every half-million kilometres driven. An average motorist will drive for about three decades without having a culpable crash-related claim, and even relatively high-risk motorists drive most years without a claim. As a result, a large number of vehicle-years worth of data are needed for statistically-reliable analysis of crash rates.

Table 2 **Vehicle Insurance Claim Frequencies in British Columbia** (ICBC 1997)

	Total	Non-culpable	Culpable	Casualty
Annual Chance of a Claim	15%	6%	9%	3%
Years/Claim	7	16	11	29
Kms/Claim	131,686	323,242	222,215	580,641
Annual Chance of a Crash	7%	3%	4%	2%
Years/Crash	14	35	24	62
Kms/Crash	282,319	692,989	476,401	1,244,820

Most vehicles are driven many years without being involved in a crash.

[14] Helen James, "Under-Reporting of Road Traffic Accidents," *Traffic Engineering & Control*, Vol. 32, No. 12, Dec. 1991, pp. 574-583.
[15] Todd Litman, "Safety and Health Impacts," *Transportation Cost and Benefit Analysis*, Victoria Transport Policy Institute (www.vtpi.org), 2004.
[16] Uncompensated crash costs include uninsured damages, insurance deductibles, and most nonmonetary damages to culpable drivers and fatal crash victims without dependents. Appendix 1 has crash cost data.

Crash rates increase with traffic density (vehicles per lane-mile),[17] so urban driving tends to have more claims per mile than rural driving.[18] But rural crashes are more dangerous.[19] Table 3 shows how crash rates vary by road type in one jurisdiction. *Crash* rates are three times higher for urban driving but *fatality* rates are about twice as high for rural driving.

Table 3 **Crash and Fatality Rates in Iowa (Per 100 Million Veh.-Miles)[20]**

	All Crash	Fatal Crash	Fatal + Injury Crash
Rural			
Interstate	57	0.45	18
Primary	133	1.97	42
Secondary	261	3.26	94
Total	*147*	*1.91*	*50*
Urban			
Interstate	137	0.69	54
Primary	472	1.15	181
Secondary	558	0.79	174
Total	*469*	*0.88*	*157*

Crash rates tend to be higher in urban areas, but fatality rates tend to be higher in rural areas.

1. Conceptual Issues

Annual crash risk can be considered the product of two factors: per-mile crash risk times annual mileage. Changing either factor affects annual crash risk. Although per-mile crash rates vary depending on various demographic, vehicle and geographic factors, most of these risk factors do not change when vehicles reduce their annual mileage. A high-risk driver may crash every 50,000 miles, while a lower-risk driver may crash every 500,000 miles, but in either case reducing annual mileage reduces annual crash rates. Even a driver who never violates a traffic rule faces risks beyond their control – an animal running into the roadway, catastrophic mechanical failure, a sudden medical problem – and most drivers take minor risks that have small but real chances of causing a crash.

Reductions in *total* vehicle travel tend to cause proportionally larger reductions in *total* insurance claim costs (assuming the reduced miles have average risk), since about 70% of crashes involve multiple vehicles and the average crash results in about 1.5 claims. Each vehicle removed from traffic reduces both its chances of causing a crash and of being the target of a crash caused by another vehicle, and each avoided multi-vehicle crash reduces multiple claims.[21]

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[17] Mary Janke, "Accidents, Mileage, and the Exaggeration of Risk," *Accident Analysis and Prevention*, Vol. 23, No. 3, 1991, pp. 183-188; Rayola Dougher and Thomas Hogarty, *Paying for Automobile Insurance at the Pump: A Critical Review*, Research Study #076, API (www.api.org), 1994.

[18] Paul Ong, "Auto Insurance Redlining In The Inner City," *Access 25*, University of California Transportation Center (www.uctc.net), Fall 2004, pp. 40-41.

[19] *National Transportation Statistics*, Bureau of Transportation Statistics, (www.bts.gov), 1997, Table 3-10.

[20] "Miles, Vehicle Miles, Accidents and Accident Rates in Iowa By Road System, 1989-1993," Transportation and Engineering Division, Iowa Department of Transportation, 1995.

[21] William Vickrey, "Automobile Accidents, Tort Law, Externalities, and Insurance: An Economist's Critique," *Law and Contemporary Problems*, 33, 1968, pp. 464-487, available at www.vtpi.org/vic_acc.pdf; Aaron S. Edlin (2003), "Per-Mile Premiums for Auto Insurance," *Economics*

For example, if you (as a an average individual motorist) reduce your chance of *causing* crashes by 10% (perhaps by driving more responsibly), your total crash risk only declines about 5%, since other drivers cause about half of your crashes. If your annual mileage declines by 10%, your total crash risk declines by 10%, and risk to other road users also declines, since you are no longer a target when other drivers make errors. If your current mileage does not change but all other vehicles reduced their mileage by 10%, you could expect a 7% reduction in crash risk, since 70% of your crashes involve other vehicles (caused either by you or the other driver). If you and all other vehicles reduce mileage by 10% you could expect a 17% reduction in total crashes, the sum of the 10% reduction from your reduced mileage plus the 7% reduction from their reduced mileage. Put differently, mileage reductions reduce traffic density (vehicles per lane-mile), which is a major factor in per-vehicle annual crash costs.

Note, however, that the vehicle that reduces its mileage, and its insurer, only capture a portion of the total benefits. One-third to one-half of crash reduction benefits accrue to other drivers and their insurers. As a result, a significantly greater reduction in vehicle travel is justified than would be perceived by individual insurers in a competitive market.

2. General Research

There is considerable empirical evidence that crashes increase with vehicle mileage, and mileage reductions reduce insurance claims and crash costs. Balkin and Ord (2001) found seasonal cycles in U.S. highway fatalities, with annual peaks during holiday seasons when VMT increases.[22] A recession in 1981-82 caused a 10% reduction in vehicle travel and a 12% reduction in insurance claims in BC.[23] Other recessions have had similar effects.[24] Female drivers' lower crash rates are approximately equal to their lower average mileage.[25] A study of young drivers found that "the consistently significant factor influencing risk of motor vehicle crash involvement was *quantity* of kilometres driven."[26] Another study found traffic casualty rates tend to decline with unemployment, probably because it reduces vehicle use by young male drivers.[27] Similarly, elderly drivers have high crash rates per mile driven, but low crash rates per vehicle-year due to their low annual mileage.[28] Figure 3 indicates a positive relationship between mileage and crash rates in the U.S.

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for an Imperfect World: Essays In Honor of Joseph Stiglitz, MIT Press; at: http://works.bepress.com/aaron_edlin/28.

[22] Sandy Balkin and J. Keith Ord, "Assessing the Impact of Speed-Limit Increases on Fatal Interstate Crashes," *Journal of Transportation and Statistics*, Vol. 4, No. 1 (www.bts.gov), April 2001, pp. 1-26.

[23] Peter Cooper, ICBC Research Services, October 1998.

[24] "State Farm to Refund Millions in Car Premiums," *Journal of Commerce*, 18 December 1991.

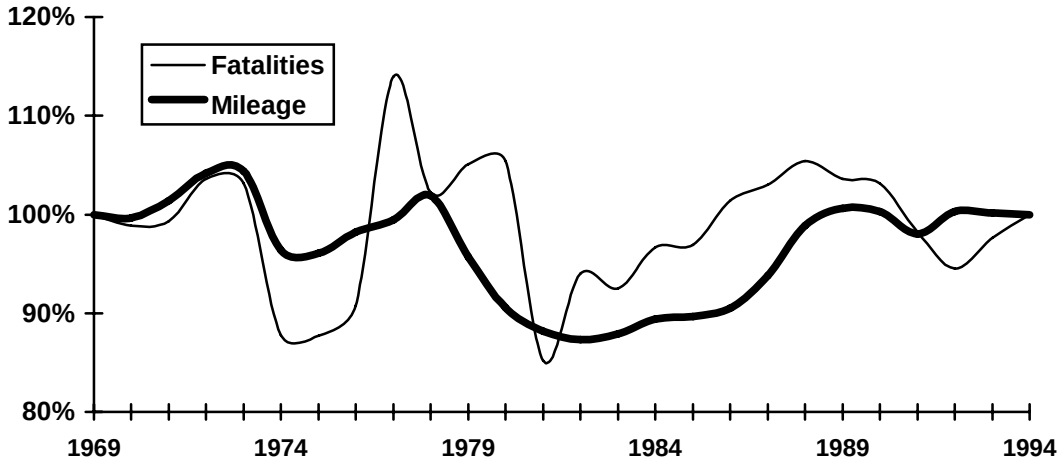
[25] Patrick Butler, "Automobile Insurance Pricing," National Organization for Women (www.now.org), presented at National Conference on Women's Travel Issues, Baltimore, 23-26 October 1996.

[26] Stephen Bath, *Influence of Socioeconomic Factors on the Exposure to Crash Risk for Young Drivers*, Traffic Safety Research Dept., ICBC (www.icbc.com), April 1993, p. 5. Original emphasis.

[27] G. William Mercer, "Influences on Passenger Vehicle Casualty Accident Frequency and Severity: Unemployment, Driver Gender, Driver Age, Drinking Driving and Restraint Device Use," *Accident Analysis and Prevention*, Vol. 19, 1987, pp. 231-236.

[28] Peter Cooper, ICBC Research Manager, quoted in *Times Colonist*, 29 June 1998, A1.

Figure 3 Vehicle Mileage and Crash Fatality Variation[29]



This figure indicates a correlation between annual mileage and crash fatalities. When vehicle travel declined in 1973-76, 1978-83 and 1990, fatalities also declined. When vehicle travel increased after 1976-78 and 1986-90, fatalities also increased.

Since about 70% of crashes involve multiple vehicles, each 1.0% mileage reduction should reduce total crash costs about 1.7%.[30] This is supported by Edlin's analysis of U.S. state-level insurance cost data, which found the elasticity of insurance costs with respect to mileage to be between 1.42 and 1.85, which means that a 10% reduction in *total* vehicle mileage reduces *total* crash costs, insurance claims and casualties by 14% to 18%.[31] Other studies reviewed in Edlin's paper support this estimate.

Additional research by Edlin and Karaca-Mandic (2002 and 2006) estimate motor vehicle insurance externalities using panel data on state-average insurance premiums and loss costs. Externalities appear to be substantial in traffic-dense states: in California, for example, they find that the increase in traffic density from a typical additional driver increases total statewide insurance costs of other drivers by $1,725–$3,239 per year, depending on the model applied. High–traffic density states have large economically and statistically significant externalities in all specifications checked and much smaller in low-traffic states, as would be expected. They estimate that a correcting Pigouvian tax could raise $66 billion annually in California alone, more than all existing California state taxes during our study period, and over $220 billion per year nationally.

[29] *Facts and Figures 95*, Motor Vehicle Manufacturers Association, 1995, p. 65 and 91. Percent variation relative to the 25 year period trend line.
[30] For example, if you reduce your mileage by 10% you would expect a 10% reduction in your crash risk. If you did not reduce your mileage but all other motorists reduced their mileage by 10% you could expect a 7% reduction in crash risk, since 70% of your crashes involve other vehicles. If you and all other motorists reduce mileage by 10% you could expect a total 17% reduction in crash risk.
[31] Edlin, op. cit.

The relationship between annual mileage and crashes for an *individual* vehicle is not linear. Per-mile crash rates tend to decline with increased annual mileage. Several factors may contribute to this:[32]

- Motorists who are higher-risk due to age or disability tend to drive lower annual mileage, while high-mileage drivers are likely to be relatively capable drivers.
- Newer, mechanically safer vehicles tend to be driven more each year than older vehicles.
- Urban drivers tend to have higher crash rates and lower annual mileage.
- High mileage motorists do a greater share of driving on safer, grade-separated highways.
- There may be other types of offsetting behaviors, by which higher-mileage drivers take more precautions to limit their risk.

These factors partly offset per-vehicle-year differences in crash rates, resulting in the crash/mileage curves that level off for high annual mileage groups, as indicated in the graphs in the next section. However, these factors represent differences *between different motorists*. Distance-based insurance is based on the relationship between annual mileage and crashes for *individual motorists*. Most of the offsetting factors listed above do not change when an individual driver reduces annual mileage. For example, a motorist who reduces from 12,500 to 11,500 annual miles in response to distance-based insurance pricing is unlikely to become less skilled, take greater chances or drive an older vehicle. Whether a motorist is relatively high- or low-risk, a reduction in their annual mileage is likely to cause a proportional reduction in their chance of causing a crash.

This is not to imply that driver behavior and road conditions do not affect crash rates, but rather that most drivers take some risks. Collisions result when drivers take such risks *and* are unlucky. Because risky driving behavior is relatively common, an increase in overall vehicle travel increases crashes.

It is possible that a travel reduction strategy could produce proportionally smaller crash reductions if it reduced low risk driving more than higher-risk driving. For example, reductions in just freeway driving could cause a less than proportional reduction in crashes. The empirical evidence described above indicates that broad reductions in driving do reduce overall crash rates, and because most serious crashes involve more than one vehicle, a given mileage reduction tends to produce a proportionally larger reduction in total crash costs and casualties. Put another way, reducing mileage provides an external safety benefit to other road users, so analysis from an individual motorists perspective will understate total safety benefits to society from mileage reductions.[33]

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[32] Janke, op. cit.; Gerald Wilde, *Target Risk*, PDE Pub. (Toronto; http://psyc.queensu.ca/target), 1994.
[33] Vickrey (op. cit. 1968) and Edlin (op. cit. 2003) discuss this concept, pointing out that optimal pricing of crash costs would usually exceed insurance cost recovery.

Driver Experience As A Risk Factor
Driver age is a significant risk factor. Young, drivers tend to have a relatively high per-mile crash rate. However, the insurance industry has been criticized for using age on the grounds that it is discriminatory and unfair, so many insurance companies have shifted from using age as a rating factor to using *experience*, referring to the number of years a motorist has driven. Insurers offer discounts based on number of years without a culpable claim or traffic violation. This is an effective mechanism, in part, because it also reflects age; most new drivers are young and so are higher risk. Some people misinterpret this to imply that high-annual-mileage drivers have low crash rates because of their greater annual "experience." This is probably not true. High-annual-mileage drivers do tend to have lower per-mile crash rates, they tend to be lower-risk type drivers and drive more on grade-separated highways, but this does not mean that if those individuals were to reduce their annual mileage, for example, in response to distance-based pricing, they would become inexperienced, higher-risk drivers.

A Dutch study of Pay-As-You-Drive (PAYD) pricing used a traffic model to assess the possible network (safety) effect of large-scale implementation.[34] Seven PAYD strategies where investigated with different kilometer-based insurance premium differentiations (road category differentiations, time differentiations, age differentiations). The study found that total safety impacts vary significantly depending on the design of the PAYD strategy. The most common effects are predicted to be mode shifts, route shifts and changes in trip frequency. To improve traffic safety, the best strategy would be to differentiate premium to reflect safety, i.e. higher fees for unsafe road categories and nighttime driving, most effectively and apply it to all drivers. This way, drivers optimize towards the lowest cost and highest traffic safety. Total crash reduction is estimated to be more than 5% with the model, resulting in a reduction of 60 fatalities and over a 1000 injured by traffic each year in the Netherlands.

Using Progressive Insurance Corporation data, Bordoff and Noel, found a strong positive relationship between mileage and claims.[35] Ferreira and Minike used mileage and insurance claim data matched for individual vehicles totaling 2.8 million vehicle-years. Their analysis found a significant correlation between miles driven and risk, and confirms that mileage is an accurate predictor of risk, particularly when normalized for other rating factors.[36] Overall, these studies confirm the actuarial soundness of PAYD pricing.

[34] Jacobus Zantema, Dirk Van Amelsfort, Michiel Bliemer and Piet Bovy (2008), *Pay-As-You-Drive: Case Study Into Safety and Accessibility Effects of PAYD Strategies*, Transportation Research Board 87th Annual Meeting (www.trb.org).
[35] Jason E. Bordoff and Pascal J. Noel (2008), *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*, The Brookings Institution (www.brookings.edu); at www.brookings.edu/papers/2008/07_payd_bordoffnoel.aspx.
[36] Joseph Ferreira Jr. and Eric Minike (2010), *Pay-As-You-Drive Auto Insurance In Massachusetts: A Risk Assessment And Report On Consumer, Industry And Environmental Benefits*, by the Department of Urban Studies and Planning, Massachusetts Institute of Technology (http://dusp.mit.edu) for the Conservation Law Foundation (www.clf.org); at www.clf.org/our-work/healthy-communities/modernizing-transportation/pay-as-you-drive-auto-insurance-payd.

Use Of Mileage As Rating Factor Decreasing, But Accurate
By Phil Gusman, *NU Online News Service*, 9 April 2009
(www.property-casualty.com/News/2009/4/Pages/Use-Of-Mileage-As-Rating-Factor-Decreasing-But-Accurate.aspx)

As some companies eliminate or reduce the significance of annual mileage as a rating factor, a new study reports a "strong correlation" between miles driven and auto insurance claim costs.

Quality Planning (www.qualityplanning.com), a unit of Insurance Services Office, that validates policyholder information for auto insurers, said it studied over 450,000 insurance policies and "found a significant difference in average claim costs between high and low annual mileage groups."

Quality Planning said the lowest annual mileage group, which drives from zero to 3,000 miles, had 44 percent fewer claims as compared to the average, while the highest annual mileage group, those who drive more than 20,000 miles, had 28 percent more claims than the average. Despite this, Quality Planning said some auto insurance companies are eliminating annual mileage as a rating factor.

Bob U'Ren, senior vice president at Quality Planning, said data verifying the decrease in use of annual mileage as a rating factor was provided by insurers that work with Quality Planning, and includes both large and small companies. Additionally, many insurers have broad mileage bands that prevent them from offering competitive pricing based on mileage, Quality Planning said.

The study noted that within broad mileage ranges, for example, zero to 7,500 miles, loss costs can be 12 to 15 percent higher for drivers at the high end of the mileage band, and 20 to 25 percent lower for drivers at the low end of the mileage band, as compared to the average for that range. "Consumers justifiably believe that if they're driving less, they should pay less for their insurance, and indeed the claims statistics support that," said Dr. Raj Bhat, president of Quality Planning. "Our study shows that those insurers who fine-tune their premium to a customer's driving habits will be better positioned to offer competitive pricing."

Robert Passmore, director of personal lines for the Property Casualty Insurers Association of America (PCI), said mileage is an important factor, but he pointed to problems insurers have with verifying miles driven. For example, "Pay As You Drive" insurance products, in which rates are based on miles driven, sometimes use GPS devices to monitor miles driven, but Mr. Passmore noted that these devices have raised privacy concerns in some states. He said consumers should know up front what such devices track, how that information is used, and how the information is protected from misuse.

Quality Planning spokesman Tim Cox, said there are other ways to track mileage besides GPS devices. Quality Planning, for example, uses methods such as car service databases to compile information, he said. When a car is serviced or is taken for an oil change, the auto shop may record the mileage. Companies can harvest information from those databases to determine mileage readings, Mr. Cox said. Mr. Passmore said as tools are developed that provide insurers with accurate information, and if those tools are approved for use, then insurers can use mileage as a rating factor in a more refined way.

For the survey, Quality Planning sampled 459,599 single-vehicle policies from multiple carriers during 2003 to 2006. The claim data from that period, the company said, was used to evaluate policy period claim costs. The annual mileage estimates were obtained from Quality Planning's RISK:check process, which the company said uses statistical estimates and odometer readings, when available.

Premium Leakage Cost Auto Insurers $15.9 Billion in 2008: Analysis by Analytics Expert Quality Planning Concludes Auto Insurers Could Stem Losses by Better Analysis and More Frequent Updates of Policyholder Information
(www.pr-inside.com/print1677365.htm)

SAN FRANCISCO, CA — 20 January 2010 Quality Planning (www.qualityplanning.com), a Verisk Analytics company that validates policyholder information for auto insurers, has released its annual premium rating error report. The report quantifies the errors and discrepancies that result in auto insurers undercharging policyholders. For 2008, Quality Planning estimates that the private passenger auto insurance industry missed $15.9 billion in revenue simply because of policyholder misinformation. In 2007, the company calculated $16.1 billion in missed auto insurance premium revenues. Although the 2008 figure is down slightly from the previous year, it is still almost 10 percent of the total $161.7 billion in personal auto premium written.

"The year 2008 saw a slight decrease in auto premium leakage over 2007. Most of this decrease is accounted for by a reduction in miles driven, which is attributable to the cumulative effects of a serious economic recession and sky-high gasoline prices — above $4.00 — in the summer of 2008," said Dr. Raj Bhat, president of Quality Planning. "Premium leakage happens. It's an undesirable, yet inevitable, aspect of auto underwriting. What insurers should understand, though, is that getting on top of the premium leakage problem is equivalent to reducing their combined ratio by three to five points."

Mileage, both annual and commute, was the most misrepresented rating factor again in 2008 and accounted for a loss of more than $3.0 billion in premium. Two other factors — unrated operators (household drivers not declared on the policy) and driver characteristics and discounts (which include inaccuracies such as driving experience, age, marital status, student discounts, affinity group membership, and misrepresentation of driver identity) — accounted for $2.6 billion and $2.3 billion, respectively.

Quality Planning recorded an upward trend in the misreporting of vehicle garaging address and of youthful drivers. The trend was most striking in large urban areas, where the actual location of where a vehicle is garaged overnight can substantially affect premium cost. Nationwide, 1 to 2 percent of all policies written include an unrated operator, who is most often a high-premium younger driver. Rated properly, those policies account for more than $2 billion of annual premium leakage.

The report, "Auto Insurance Industry Leaves Billions on the Table," can be found online at the company's website, www.qualityplanning.com. The report aggregates and summarizes audit results of more than four million policies from multiple carriers, and draws from business written in all states except Hawaii and Alaska. The sample includes substandard to preferred books of business, all distribution channels, and national and regional carriers (1). Sample results were weighted to reflect the total national private passenger auto line.

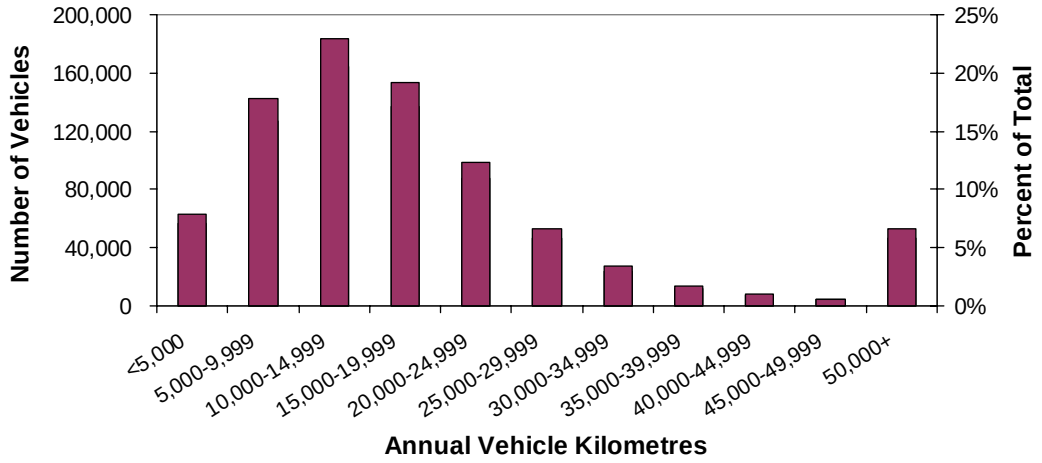
The 2008 report includes a detailed analysis that distinguishes between vehicle rating errors (mileage, usage, type of vehicle, and location) and driver rating errors (driving experience and driving record) and shows how different categories of rating error contribute to overall premium rating error. Quality Planning urges auto insurers to improve their analysis of policyholder-rating data to identify and correct flawed information — steps that could have a positive effect on overall corporate profitability.

3. Insurance Claim/Mileage Data Analysis

In the past, there was little reliable information on the relationship between individual vehicles' annual mileage and crashes. Most insurance companies collect little or no mileage data, and any information they do collect is self-reported, which vehicle owners tend to understate to qualify for lower rates.[37] Other data is highly aggregate, based on total vehicle travel and crashes in a region or country.

Mileage readings collected during emission checks in the Vancouver, British Columbia region were matched with individual vehicles' insurance claim records for more than 500,000 vehicle-years.[38] Figure 4 illustrates the distribution of vehicles by annual mileage category (the term "mileage" is applied in this report to vehicle-kilometers).

Figure 4 **Distribution of Annual Vehicle Kilometres**



This figure shows the distribution of vehicle-kilometres. The median is about 20,000 kms.

These data were disaggregated by crash history status, rate class, and location. Table 4 summarizes the distribution of these factors.

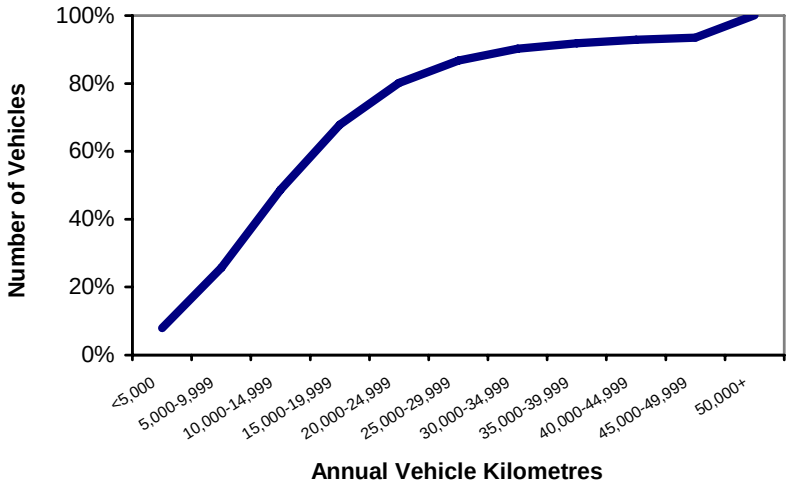
Table 4 **Distribution by Analysis Category**[39]

Crash History	**Low-Risk**	**Higher-Risk**	
	385,487 (68%)	177,047 (32%)	
Vehicle Class	**Pleasure**	**To Work/School**	**Business**
	222,191 (39%)	263,827 (47%)	76,516 (14%)
Location	**Urban Core**	**Urban Fringe**	**Other**
	500,009 (89%)	31,301 (6%)	31,224 (6%)

Figure 5 illustrates cumulative vehicle travel.

[37] One company found that 39% of its customers under-report distance to work, *Large Insuer Generates Millions in Additional Premiums With GUS Technology*, Insurance Service Office (www.iso.com).
[38] Since the Insurance Corporation of British Columbia insures all vehicles registered in the province the data include virtually all significant crashes and the majority of all insurance claim costs.
[39] "Low-Risk" vehicles have at least nine continuous years without an at-fault claim.

Figure 5 **Cumulative Vehicle Travel**



This figure shows the cumulative distribution of vehicle-kilometres. More than 90% of vehicles are driven less than 30,000 kilometres per year.

Data Collection and Accuracy

Since 1993, automobiles registered in the Vancouver region have been required to have an emission test at *Aircare* inspection stations prior to their annual registration. This involves a visual inspection of emission equipment, an idle emission test, a running emission test using a dynamometer, and collection of odometer readings. The test takes about 6 minutes and costs $18.

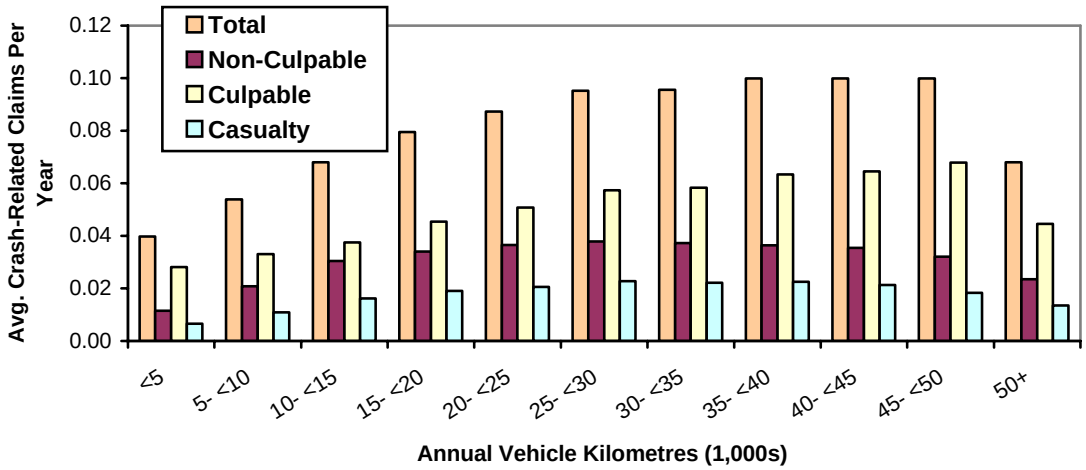
Two continuous annual odometer readings on a particular vehicle can be used to calculate its annual kilometres. This information is then matched to its insurance claim records creating a unique database of the relationship between vehicle travel and claims. Of 1,028,460 total vehicle-years recorded during 1995-98, about 10% had values outside the 0-150,000 km/yr acceptable range. Others lacked the full set of data (model year, driver age, gender, residence location, and claim history) required for this analysis, leaving 562,534 vehicle-years suitable for analysis.

Odometer readings are reported verbally by drivers to inspection station staff, creating the possibility of several types of errors, including misreported readings, mistyped numbers and miles miss-recorded as kilometres. The number of vehicles in the highest (>50,000) category is probably exaggerated due to the tendency of false readings to fall into this category at a greater rate than the other ten. There is a 67% chance of errors that are equally distributed throughout the 150,000 km range to fall into the >50,000 category, while only 3% of such errors would fall into any of the other ten categories. Other types of errors that result in order-of-magnitude underestimates (such as recording 1,563 rather than 15,639) tend to fall into the <5,000 category.

For this reason, the number of vehicles in the >50,000 km category in particular, and the <5,000 km category to a lesser degree, are probably overstated, and their annual crash values are skewed toward overall averages. This probably explains the extremely low per-kilometre crash rate for the >50,000 group, and the high per-kilometre crash rate for the <5,000 group.

Figure 6 illustrates the relationships between annual vehicle kilometres and crash rates for vehicles in aggregate. It shows that both culpable (at-fault) and non-culpable (not at-fault) crashes tend to increase with annual vehicle-kilometres in the 0-35,000 km/vehicle-year range, representing the majority of vehicles. The low crash rates in the highest kilometre (50,000+) category is believed to result, in part, from data errors that incorrectly assign lower-mileage vehicles to that group.

Figure 6 **Crash Rates by Annual Vehicle-Kilometres**

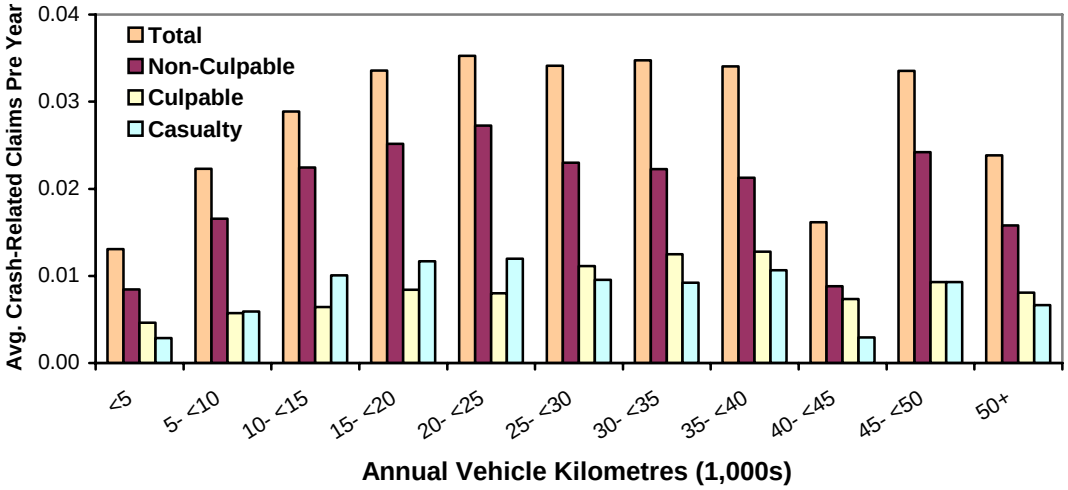


Crashes tend to increase with annual kilometres at the aggregate level.

These data show similar results when disaggregated by vehicle rate class, driver history and territory, such as the example illustrated in Figure 7. Crashes increase with mileage for virtually all categories, at least in the common (5,000-25,000 km/yr) mileage range. Other mileage groups exhibited some random variance due to their small numbers. The relationship between annual mileage and annual crashes is probably much stronger than these aggregate data indicate due to offsetting factors that result in low-per-mile crash rates for high-annual-mileage vehicles, and high-per-mile crash rates for low-annual-mileage vehicles. In the past, actuaries lacked accurate annual-mileage data and so were unable to evaluate mileage as a risk factor. As a result, they underweigh mileage and overweigh other factors such as gender and driver history.[40] For example, men tend to drive more annual miles than women and have proportionally higher crash rates, so actuarial analysis indicates that men have higher crash rate than women because gender is a surrogate for mileage. But men who drive 10,000 annual miles have lower annual crash rates than women who drive 15,000 annual miles. Incorporating accurate mileage data allows actuaries to determine what factors truly affect per-mile crash rates. The results are likely to show stronger relationships between annual mileage and crash rates.

[40] Patrick Butler and Twiss Butler, "Driver Record: A Political Red Herring That Reveals the Basic Flaw in Automobile Insurance Pricing," *Journal of Insurance Regulation*, Vol. 8, No. 2, Dec. 1989, pp. 200-234. Gerald Wilde, *Target Risk*, PDE Publications (Toronto; http://psyc.queensu.ca/target), 1994.

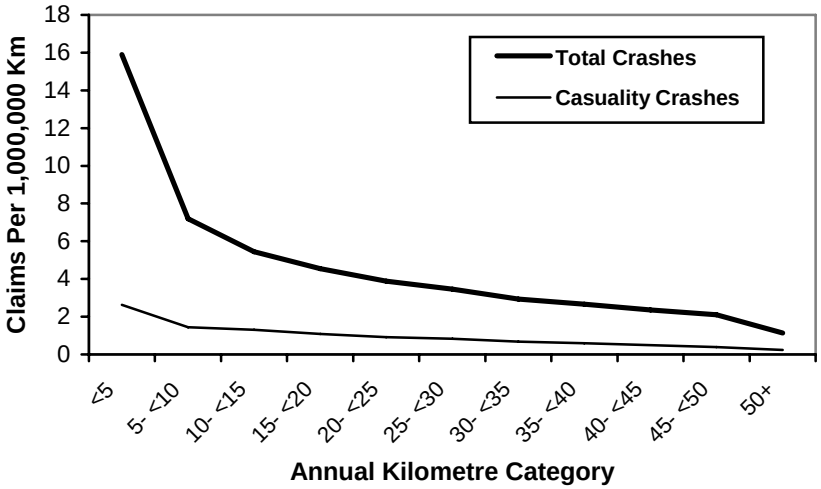
Figure 7 **Example of Disaggregated Crash Data** (Low-Risk, Pleasure, Urban Core)



This is an example of crash rate data for one of 18 rate categories analyzed.

Figure 8 shows that crash and casualty rates *per kilometer* decline with increased mileage, although crash rates *per year* increase. However, as discussed previously, this does not mean that a vehicle that reduces its annual mileage would necessarily shift along the curve, increasing its crash rate, since the data compare *different* vehicles, and do not necessarily represent the effects of changes in travel by individual vehicles.

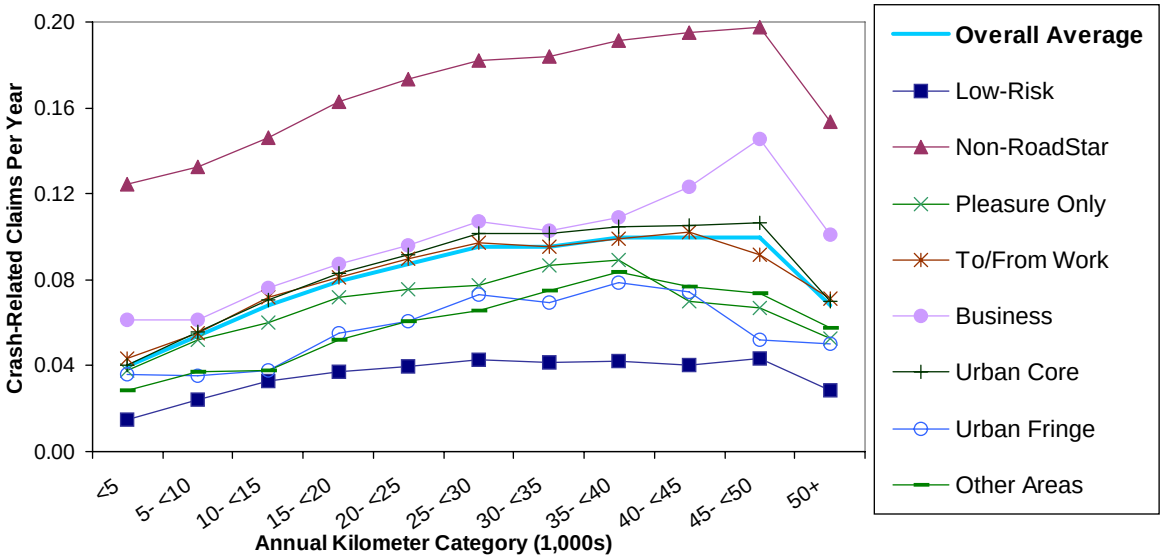
Figure 8 **Claims Rate by Kilometre Category**



This figure shows how average claim rates decrease with annual vehicle travel.

Figure 9 shows annual crash rates disaggregated into some major categories. Crashes generally increase with annual vehicle-kilometres at least up to 35,000 annual kilometres, which represents more than 90% of all vehicles.

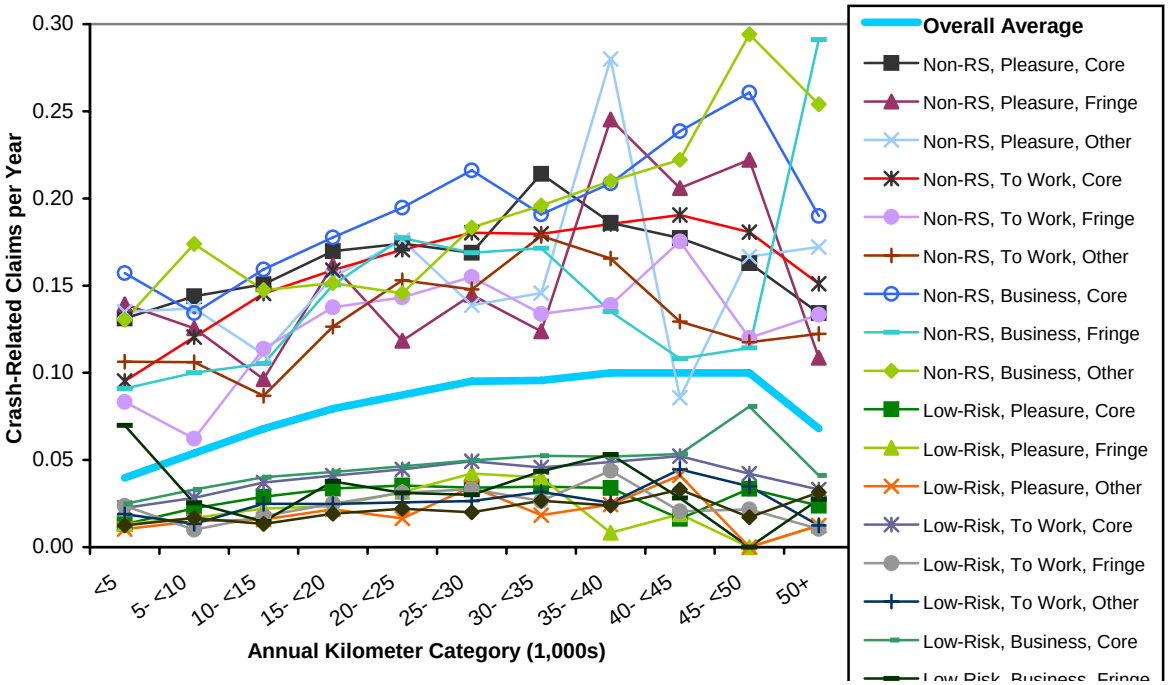
Figure 9 **Crashes Per Year By Major Category and Annual Kilometres**



All major rate categories show a positive relationship between crashes and kilometres.

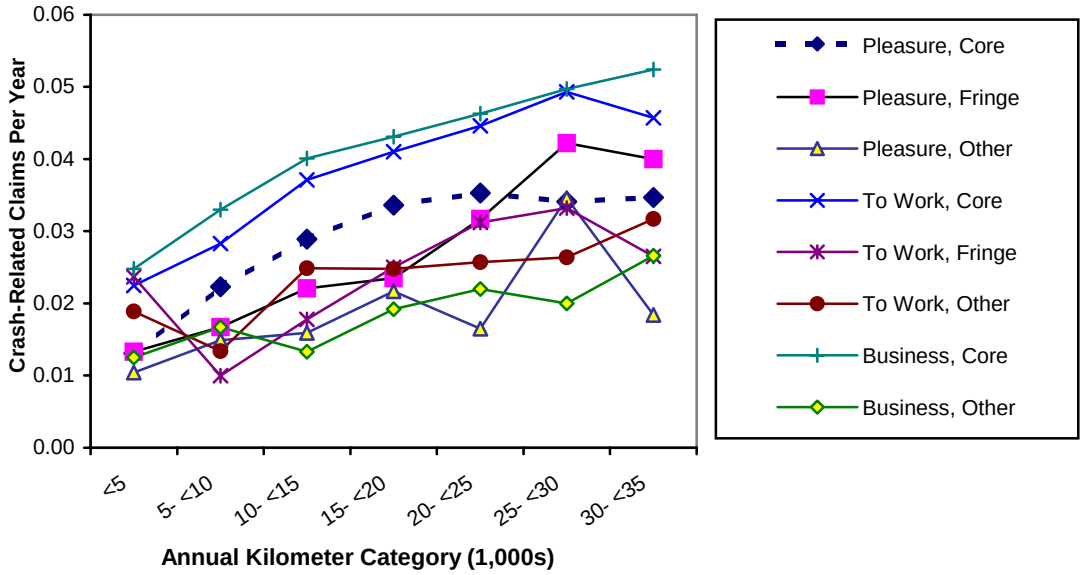
Figures 9 and 10 illustrate the relationship between annual kilometres and crashes for individual price categories. This analysis is important because it shows that lower-mileage vehicles have fewer annual claims than higher mileage vehicles within specific price groups. This indicates that distance-based pricing is essential for fair pricing.

Figure 10 **Crashes Per Year By Price Category and Annual Kilometres**



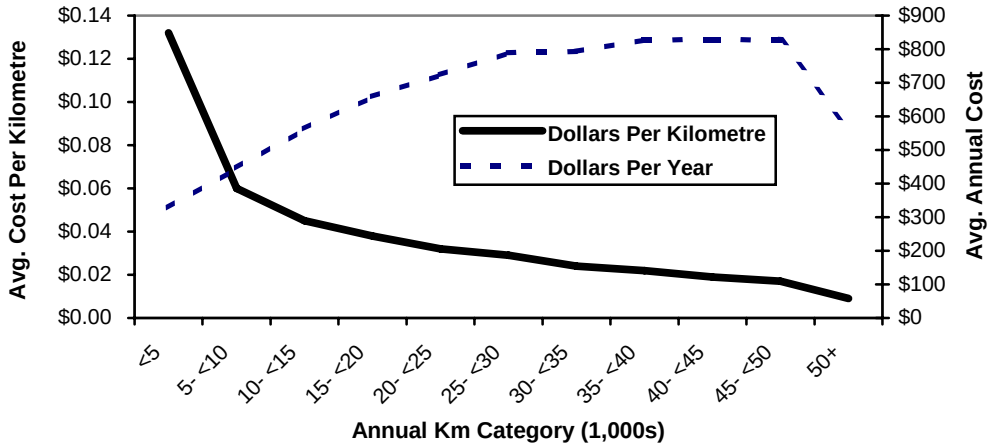
Annual crash rates vary by price category, and tend to increase with vehicle-kilometres.

Figure 11 **Crashes Per Year By Lower-Risk Price Categories**



This shows crash rates for the 68% of vehicles that are considered Low-Risk. Note these are the same curves that are squeezed at the bottom of Figure 10.

Figure 12 **Avg. Insurance Costs Per Vehicle-Kilometre and Vehicle-Year**

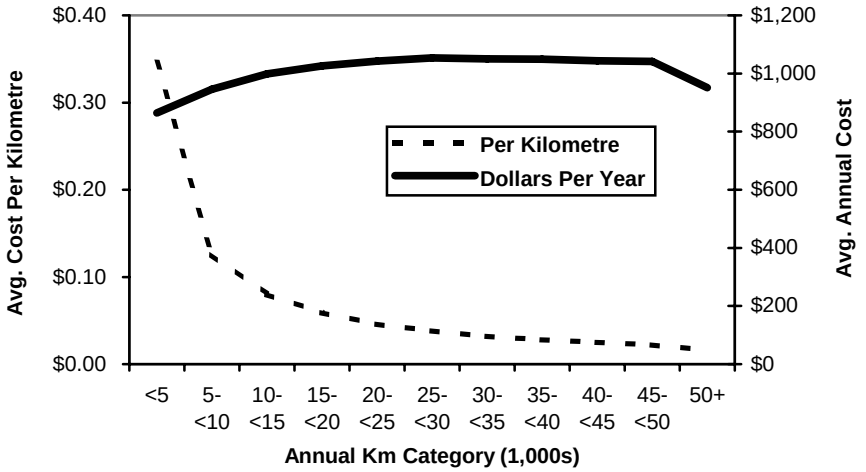


Costs per kilometre decrease with vehicle travel, while costs per vehicle-year increase.

Figure 12 shows insurance costs per kilometre and per vehicle-year.[41] Figure 13 indicates that annual average premiums currently paid do not vary significantly with annual-kilometre category. This indicates that lower annual-kilometre vehicles overpay and higher annual-kilometre vehicles underpay their true insurance costs.

[41] Based on $8,293 average costs of crash-related claims. From "Ultimated Crash Analysis" plus 20% for general overhead expenses.

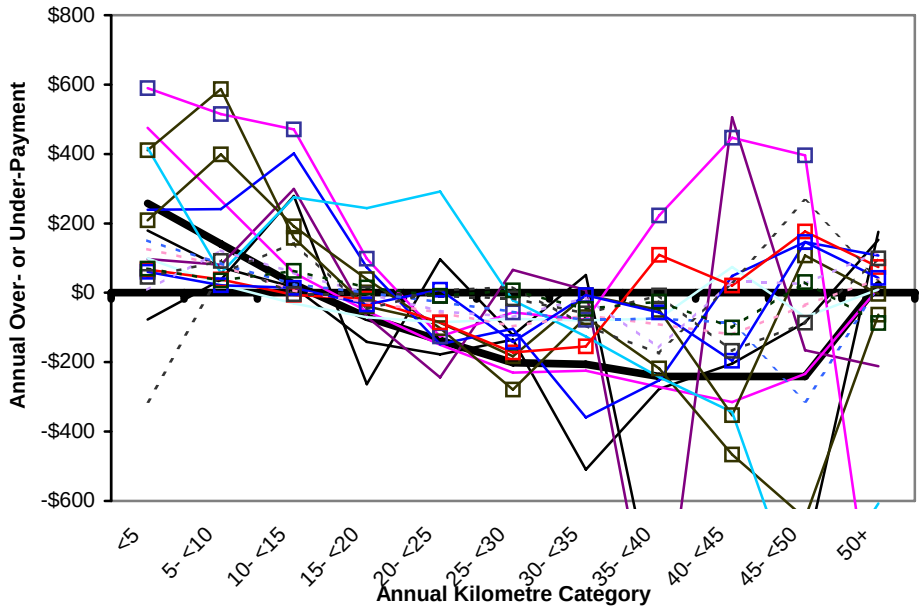
Figure 13 **Average Annual Premiums by Kilometre Category**



Low annual-mileage vehicles pay about the same annual premiums as high mileage vehicles, resulting in much higher costs per kilometre driven.

Figure 14 illustrates how lower annual-kilometre vehicles overpay, and high annual-kilometre vehicles underpay if insurance premiums are actuarially accurate for their price category, but do not take into account annual kilometres.

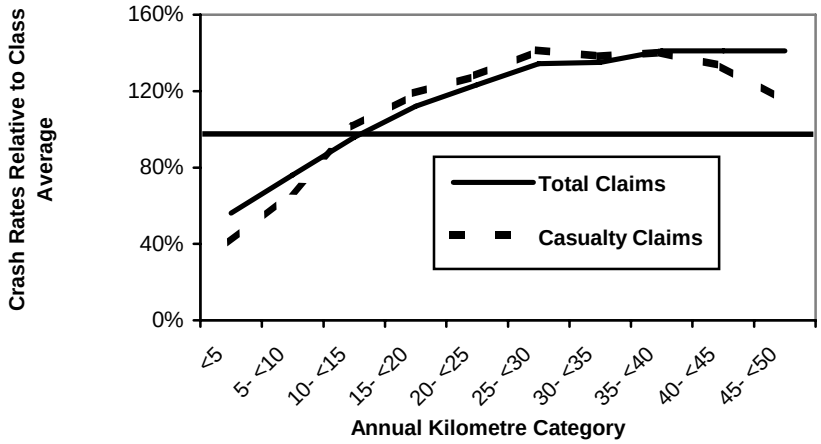
Figure 14 **Premium Versus Insurance Costs**



This figure illustrates the degree to which vehicles over- or under-pay their true insurance costs if premiums are based on price category average crash rates. The heavy line shows the overall average. The high degree of scatter in the higher-mileage range results from the small number of vehicles in these categories.

The analysis described so far includes all types of crashes. Figure 15 shows that both Total (solid lines) and Casualty-Only (dashed lines) crash rates have similar patterns with regard to annual vehicle-kilometres. Although casualty claims have more variation, this is explained by their smaller sample size. The two averages (bold lines) track closely.

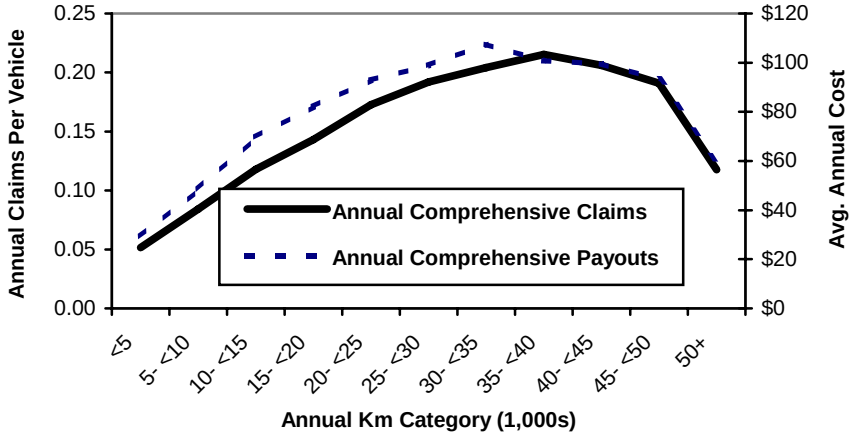
Figure 15 **Variation of Total and Casualty Crash Related Claim Rates**



This figure shows that crash and casualty rates follow similar patterns.

Comprehensive claims (for vandalism, theft, weather damage and glass chips) were also analyzed separately. It is possible that these are unrelated to mileage, since such damages can occur when a vehicle is parked. However, the data show that such claims do increase with annual vehicle kilometres, as indicated in Figure 16 (excepting very high-mileage classes, which are probably inaccurate). Driving increases a vehicle's exposure to comprehensive-coverage risks, including paint and glass chips that occur while driving, and other damages if away-from-home parking this is less secure than at-home parking. This indicates that distance-based pricing should apply to all types of insurance coverage.

Figure 16 **Average Annual Comprehensive Claims and Costs**



Claims and costs for comprehensive claims also increase with annual vehicle-kilometres.

4. Setting Distance-Based Rates

Data described earlier in this report support the often-made claim that a driver's history is the single most important factor in predicting future crashes. Drivers who do not qualify for safety discounts have about five times the claim frequency as those who do. The data also show that per-mile crashes decline significantly with annual mileage. At first glance, this implies that annual vehicle mileage is unimportant as a rating factor.

However, within virtually all rate groups, annual crash rates increase with annual vehicle-kilometres. Within each group, lower annual kilometre vehicles tend to have lower crash rates and so overpay their insurance costs, while higher kilometre vehicles have more crashes and underpay relative to their insurance costs.

This indicates that actuarially accurate pricing requires several rating factors, including annual mileage, driving history, vehicle use and territory. It would not be actuarially accurate to use annual mileage *instead* of other rating factors, for example, to charge all motorists a 5¢ per mile insurance fee regardless of other risk factors, but it would significantly improve actuarial accuracy to incorporate annual mileage *in addition* to existing rating factors. Any other pricing structure causes significant cross-subsidies from low to high annual mileage vehicles, and fails to provide consumers with efficient price signals because it does fails to reward drivers for behavior that reduces crashes.

Four levels of analysis should be applied when calculating distance-based premiums:

1. First, consider the overall relationship between mileage and claims. This is what most available data provide.
2. Second, consider the relationship between mileage and claims for the particular group of motorists who choose distance-based insurance (assuming it is a consumer option). This group will consist almost entirely of lower-mileage motorists, typically those who drive less than 80% of average mileage for odometer-based pricing (i.e., with minimal participation costs), and less than about 40% of average mileage for GPS-based pricing (due to the high participation costs). There may be other factors that affect the type of motorists who participate. For example, some distance-based pricing programs are only available to motorists GPS-equipped vehicles who subscribe to location-related services such as OnStar. This will limit participation to motorists with relatively new vehicles. Other distance-based insurance programs may be marketed to a particular groups, such as transit commuters or employees of a certain industry, and so will have other particular attributes. Setting accurate rates will require disaggregating available data to understand the crash and claim rates for these types of drivers, and converting these into per-mile units.
3. Third, consider how mileage reductions that result from this price incentive affect claim costs. For example, if distance-based pricing caused participating motorists to reduce their mileage and premium payments by 20%, but claim costs only decline 10%, the insurer would be financially worse off. It will therefore be important to understand the types and claim rates of the mileage reduced. If motorists tend to reduce higher-than-average-risk miles in response to this price incentive, claim cost savings will be relatively large. If motorists tend to reduce lower-than-average-risk miles, claim cost savings will be relatively small.
4. Fourth, insurers who control a significant portion of the vehicle insurance market in an area can also take into account the additional savings that result when motorists

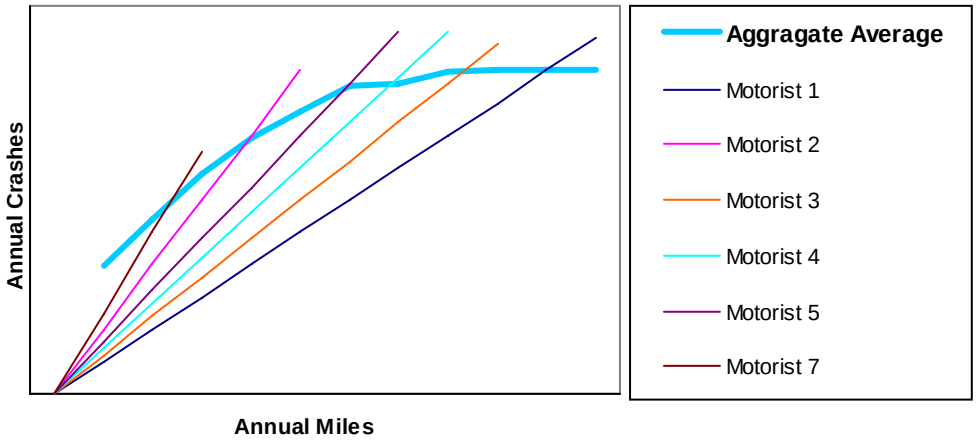
> reduce their mileage in response to distance-based pricing, and therefore the savings to their other policies. For example, a 10% reduction in mileage by a group of 10,000 motorists with distance-based insurance might provide $1,000,000 annual claim cost savings to the motorists who have such policies (that is, to those who do reduce their mileage), plus $500,000 in savings to other policies (for vehicles that don't reduce their mileage). If the insurer has 50% of that market, it would save an additional $250,000 in claim costs on those other policies, a portion of which could be passed back as additional financial discounts to those who reduce mileage.

As discussed earlier, low-mileage motorists have relatively high claim costs, and the data indicate that in many situations, annual mileage reductions provide little reduction in claims. For example, the data indicate that motorist who drive less than 5,000 kilometers annually have claim costs averaging about $300 annually, while those who drive more than 30,000 kilometers annually have claim costs averaging less than $900 annually, indicating that more than a six-fold increase in mileage causes less than a three-fold increase in claim costs. However, many of the factors that cause lower-mileage motorists to have relatively high per-mile crash costs, and high-mileage motorists to have relatively low per-mile crash costs, can be address directly through existing or new rating factors. For example, young, elderly and urban motorists tend to have higher per-mile claim rates. As a result, these motorists should be charged more per vehicle-mile (typically 8-16¢ per mile) than middle-age, rural motorists (typically 2-4¢ per mile).

Similarly, the data suggest that a reduction from 45,000 to 30,000 annual kilometres provides little or no crash cost savings, but this is probably an artifact of the data. The data show crash/mileage relationships *between different vehicles*. For various reasons, higher annual mileage motorists tend to have low per-mile crash rates and lower annual mileage tend to have higher per-mile crash rates. However, these factors do not usually apply to a reduction in mileage by an *individual* motorist. A marginal reduction in mileage in response to a financial incentive is unlikely to cause a driver to become less experienced, more careless, or shift their driving to significantly higher-risk conditions. Put another way, it makes little sense that the first miles a vehicle is driven during an insurance-year are higher-risk than miles driven by the same vehicle later in the year, although this is implied if the data are interpreted literally.

Figure 17 illustrates how individual crash curves can result in an aggregate curve that levels off. An individual vehicle's curve is approximately linear, so a mileage reduction causes a proportional reduction in claims. This indicates that there is little or no reason to use a declining block rate for distance-based insurance pricing. As insurance companies gain experience with distance-based pricing they will be able to better determine per-mile risks of different types of motorists, and develop more accurate per-mile premiums.

Figure 17 **Crashes Per Year**



Individual motorists' curves are probably straighter than the aggregate.

The data show a positive relationship between annual mileage and all forms of insurance coverage, including comprehensive claims. Comprehensive claims may be less affected by mileage than crash-related claims (the elasticity of claims with respect to annual mileage may be less than 1.4). However, many comprehensive claims are for glass and paint chips caused by debris thrown by passing vehicles, which *are* likely to increase with traffic density, and risk of theft and vandalism may be lowest when a vehicle is parked at its residence, and so tends to increase with vehicle use. Only with experience can insurance actuaries learn how much vehicle mileage will affect various types of claims.

Because total crash costs should decline more than mileage, the overall financial risks from comprehensive distance-based insurance are small. For example, if drivers reduce their annual mileage by 10%, total crash costs should decline by 14% to 18%. However, much of these savings go to other road users and their insurers. Individual insurance companies in a competitive market only perceive about a third of the full incentive to implement distance-based pricing. Competing insurers would capture about one-third of total claim cost savings, and even greater benefits would consist of reductions in uncompensated crash costs.[42] For this reason, distance-based insurance is unlikely to be implemented voluntarily by insurance companies to the degree that it is socially justified. This distribution of benefits helps explain why insurers perceive relatively little incentive to implement distance-based pricing or other mileage-reduction strategies.

[42] Assuming 70% of crashes involve multiple vehicles, and that each vehicle bears about equal costs. See discussion in Edlin, 2003.

Pricing Alternatives

This section describes and compares distance-based pricing options. See Appendix 1 for technical details of the analysis framework.

1. Mileage Rate Factor (KRF)

Self-reported estimates of annual mileage are incorporated as a rate factor in existing premiums.

A. How It Works

Vehicle insurance could become more distance-based by incorporating a Mileage Rate Factor into the existing rate structure. Premium payers would predict how much they expect to drive a vehicle during the term of coverage, and premiums would increase with higher annual mileage categories.

Such estimates are inherently inaccurate because premium payers cannot predict their future travel with certainty. A change in job, health or lifestyle can change annual mileage. Insurance companies that collect mileage data usually have no mechanism to verify such estimates or impose penalties for inaccuracy. As a result, motorists tend to significantly underestimate their vehicle mileage. Insurers typically find that 60-70% of motorists claim to drive less than 7,500 miles per year and 95% claim to drive less than 10,000 miles per year, although vehicles actually average more than 12,000 miles.[43] Due to the unreliability of this data, insurance companies must limit price differences between mileage classes.[44]

Most insurers that use mileage as a rating factor have just a few mileage categories, which provides little incentive for more efficient travel behavior since motorists only perceive savings if they expect that a particular mileage reduction may shift them into a lower price category. More marginal pricing would require smaller categories.

For more credible data insurers could have insurance brokers verify readings or perform random spot checks, with penalties if reading were higher than predicted.[45] Premiums would be adjusted at the end of the term if actual vehicle-miles differ from what was predicted. As odometer checks become more common and comprehensive, and mileage units become smaller, the benefits and costs of this strategy converge with Per-Mile Premiums, described later.

B. Price Structure

The table below illustrates an example of this rate structure with a 2% price reduction for each 1,000 miles, resulting in a marginal savings of about 1.4¢ per mile for an average vehicle. Although this is less than what is actuarially justified, it represents the likely upper limit of this pricing strategy if based on self-reported estimates.

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[43] Patrick Butler, Twiss Butler and Laurie Williams, "Sex-Divided Mileage, Accident, and Insurance Cost Data Show that Auto Insurers Overcharge Most Women," *Journal of Insurance Regulation*, Vol. 6, No. 3&4, 1998, p. 390.
[44] Ibid, 391-392.
[45] Dean Baker and Jim Barrett, *The Feasibility of Pay by the Mile Automobile Insurance*, Economic Policy Institute (Washington, www.epinet.org), 1998.

Table 5 **Example of Mileage Rate Factor**

Mileage Range	Rate Factor	Premium	Change
<5,000	0.88	$588	-$112
5,000-6,999	0.91	$616	-$84
7,000-8,999	0.94	$644	-$56
9,000-10,999	0.97	$672	-$28
11,000-12,999	1.00	$700	$0
13,000-14,999	1.03	$728	$28
15,000-16,999	1.06	$756	$56
17,000-18,999	1.09	$784	$84
>19,000	1.12	$812	$112

This table illustrates an example of Mileage Rate Factor.

C. Market Penetration

Mileage Rating could be standard on all policies or as a consumer option. Data described earlier in this report indicate that all types of claims tend to increase with annual mileage, and so a Mileage Rate Factor is justified for nearly all types of coverage.

D. History of This Concept

Actuaries have always recognized mileage as a significant risk factor, but face practical problems collecting accurate data, and conflicts with other objectives that rely on overpayments by lower-mileage drivers (called "cream skimming") to make premiums more affordable for higher-mileage drivers.[46]

California voters passed Proposition 103 in 1988, which requires insurers to place more weight on driving record and mileage, and reduce weight on demographic and geographic factors. A 1993 study indicated that insurers had failed to meet these requirements,[47] and little progress has occurred since.[48] Lack of mileage verification appears to be the primary factor limiting implementation.

E. Actuarial Accuracy

In theory, a Mileage Rate Factor can be any size needed for actuarial accuracy, but without verification and enforcement it is constrained by motors' tendency to understate their annual mileage if given a financial incentive. As a result, only a small portion of the actuarially appropriate weight can be placed on distance using self-reported mileage data.

F. Implementation Requirements

Incorporating mileage as a rating factor would require insurers to revise and republish their rate plans, and updating computer databases to accommodate an additional field. These are one-time transition costs. More credible data would require mileage verification and penalties for under-reporting, which increases implementation costs to those of the Per-Mile Premiums described later in this report.

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[46] Patrick Butler, Twiss Butler and Laurie Williams, 1988, pp. 405-407

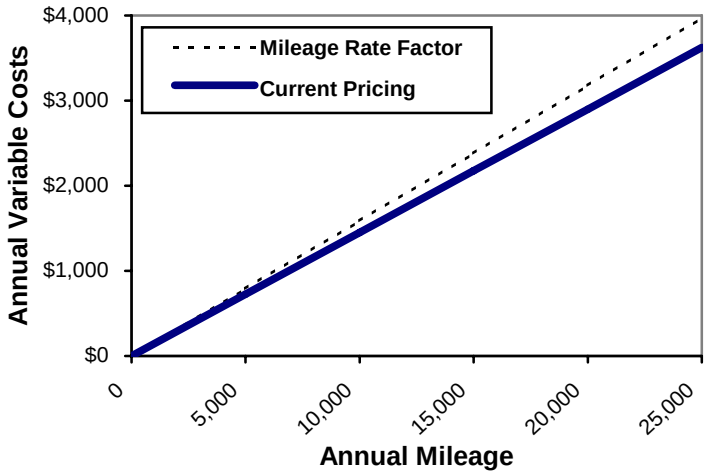
[47] Lyn Hundstad, Robert Bernstein and Jerry Turem (1994), *Impact Analysis of Weighting Auto Rating Factors to Comply with Proposition 103*, California Dept. of Insurance (www.insurance.ca.gov).

[48] Robert Bernstein, California Department of Insurance, telephone conversation, June 1998.

G. Travel Impacts

This price structure increase variable vehicle costs an average of 10%. Figure 18 illustrates how this compares with the current variable cost of driving.

Figure 18 **Mileage Rate Factor Impact on Variable Costs[49]**



This figure illustrates how Mileage Rate Factor increases variable costs.

Standard elasticity values suggest that this would reduce vehicle travel 1-3%. However, using self-reported estimates of future travel with large annual-mileage categories, no verification or enforcement, and annual payment would probably cause minimal travel reductions since drivers would perceive little relationship between a particular trip decision and their insurance costs. Actual mileage reductions would probably be about 1%.

H. Equity

Incorporating mileage as a rate factor increases actuarial accuracy and therefore horizontal equity (individuals would bear the costs they impose) compared with current pricing. It also tends to increase vertical equity by making vehicle insurance more affordable and providing savings to lower-income households, which tend to drive vehicle less than average annual mileage.[50] Because the rating factor would be relatively small, these impacts tend to be small. Pricing based on self-reported data could introduce a new form of inequity: honest premium payers overpaying compared with those who understate their annual mileage.

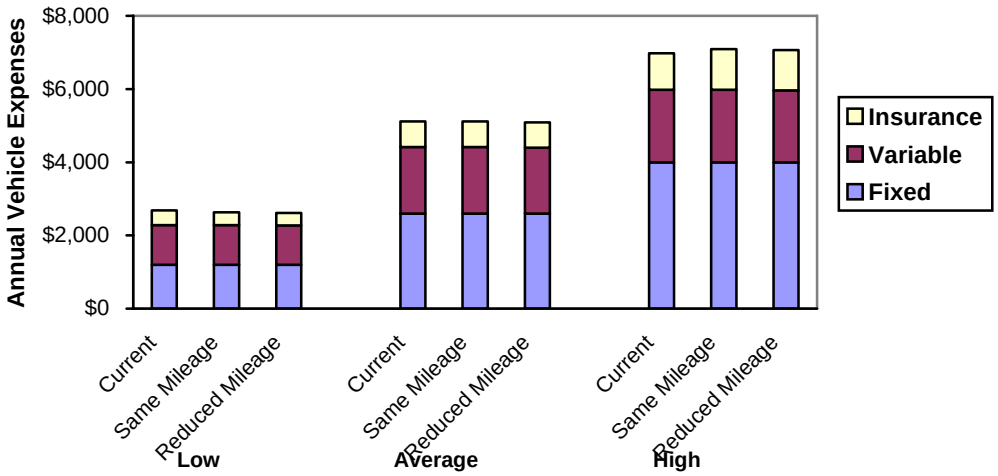
[49] Costs described in Appendix 2.

[50] According to the Bureau of Labor Statistics *Consumer Expenditure Survey*, the lowest income quintile consumes about 10% less fuel per vehicle, and the highest income quintile consumes about 10% more fuel per vehicle than the overall average. This and other studies summarized in Appendix 1 indicate that annual mileage per vehicle increases with income, indicating that PAYD is directly progressive with respect to income, and is likely to be more so because lower-income consumers tend to be highly price sensitive, and so achieve additional benefits when offered a new opportunity to save money.

I. Consumer Impacts

Low-mileage drivers pay less and high-mileage drivers pay more with Mileage Rate Factor, but these changes are small overall, as illustrated in Figure 19.

Figure 19 **Current and MRF Costs Compared**



This figure illustrates how MRF affects total vehicle costs. "Current" refers to vehicles with fixed-price insurance. "Same Mileage" refers to vehicles with MRF that do not reduce annual mileage. "Reduced Mileage" assumes a 1% mileage reduction. Overall impacts are small.

A low-mileage vehicle with basic insurance such as might be used by a lower-income household saves about $52. An average vehicle that continues its current mileage experiences no costs change. A high-mileage vehicle pays $110 more per year, or $106 if mileage declines as expected. These changes are small relative to total vehicle costs.

Table 6 **Mileage Rate Factor Consumer Cost Impacts**

Vehicle	If Vehicle Use is Unchanged	If Vehicle Use Declines 1%
Low (6,000 miles/yr)	-$52 (-1.9)	-$53 (-2.0)
Medium (12,500 miles/yr)	$0 (0.0%)	-$2 (0.0%)
High (18,000 miles/yr)	$110 (1.6%)	$106 (1.5%)

(Percentages in parenthesis indicate insurance cost changes relative to total vehicle costs.)

This example may give a false impression that overall loses are greater than overall gains because it shows a greater cost increase to the higher-mileage motorist than savings to the lower-mileage motorist. There are far more vehicles driven 6,000 miles than 18,000 miles annually (Figure 4). Direct financial gains would equal direct financial losses if there are no mileage reductions, and total gains exceed total losses if mileage declines.

J. Public Acceptability and Marketing

Surveys suggest that the public generally supports efforts to incorporate mileage into insurance premiums particularly if presented as a positive reward.[51] Because Mileage Rate Factor requires minimal changes few motorists would consider it threatening, but there would also be few strong advocates. Consumers would probably be uncomfortable placing significant weight on self-reported data, since it rewards dishonesty.

K. Crashes

A 1% reduction in vehicle travel is expected to reduce crashes 1.2%.

L. Energy Use and Emissions

A 1% reduction in vehicle travel is expected to reduce fuel use and emissions by 1%.

M. Economic Efficiency and Development

Incorporating vehicle-mileage as a rate factor allows premiums to better reflect insurance costs, and therefore increases economic efficiency compared with current pricing. However, the impacts are small and so benefits would be small.

N. Summary of Advantages and Disadvantages

Advantages:

1. Minimum implementation costs.

Disadvantages:

2. Based on unreliable data.
3. Is not marginal because pricing is based on large mileage units.
4. Minimum effect on vehicle travel and consumer costs results in minimum benefits.
5. Rewards motorists for dishonesty (understating annual mileage).

[51] Viewpoints Research, *Travel Demand Management: A Qualitative Analysis of Public Views*, BCTFA-GVRD, 1996. Also see Proposition 103 history described in Hundstad, Bernstein and Turem, 1994.

2. Pay-at-the-Pump (PATP)

Basic insurance coverage is funded through a surcharge on vehicle fuel sales, plus additional charges for higher-risk drivers. Other coverages are funded as they are now.

A. How It Works

Pay-at-the-Pump uses fuel surcharges to fund vehicle insurance. Table 7 summarizes three examples of PATP proposals.

Table 7 **Pay-at-the-Pump Proposals Compared[52]**

	Tobias[53]	VIP[54]	PPN[55]
Coverage	Basic liability, medical, collision and theft.	Basic bodily injury (no property damage).	Basic liability and medical.
Fuel surcharge	US 40¢/gallon	US 30¢/gallon	US 30-40¢/gallon
Portion of revenue from fuel charge.	65-75%	58%	60-70%
Other revenue	Registration surcharges for higher-risk vehicles. Licensing surcharges for higher-risk drivers. Traffic citation surcharges.	Annual registration surcharges averaging US$80. Vehicle purchase charges up to US$250 per vehicle. Licensing surcharges.	US$200/year vehicle registration surcharge. US$100/traffic ticket surcharge. Additional fees on alternative fuel vehicles
Administration	Coverage for blocks of 2,500-5,000 vehicles would be auctioned to insurance companies.	State management with private insurance companies providing claims administration.	State management with private insurance companies providing claims administration.

This table compares three examples of PATP proposals.

Table 8 summarizes the scope of PATP coverage. Most motorists would need to purchase additional coverage for optional and out-of-jurisdiction travel.

Table 8 **Insurance Coverage by Pay-at-the-Pump**

Typically Covered	Typically Not Covered
Basic liability for collisions by gasoline-powered vehicles that occur within the state or province that has PATP.	Extended liability. Collision Comprehensive Out-of-jurisdiction travel. Vehicles using fuel other than gasoline.

PATP proposals typically provide only a portion of total vehicle insurance coverage.

PATP provides universal coverage and so is attractive in jurisdictions with high rates of uninsured driving. More than 10% of claims are uninsured in some jurisdictions.[56] A

[52] Also see Wenzel, 1995; J. Daniel Khazzoom, *Pay-At-the-Pump (PATP) Auto Insurance: Criticisms and Proposed Modifications*, Resources for the Future, Discussion Paper 99-14 (www.rff.org), 1999; Arthur Rosenfeld, Auto Insurance: *Pay Per Gallon, Refund per Mile To Maximize Savings of Gasoline and CO2*, Energy Efficiency and Renewable, US Dept. of Energy, 2000.
[53] Andrew Tobias, *Auto Insurance Alert*, Fireside (New York), 1993.
[54] Stephen Sugarman, *"Pay at the Pump" Auto Insurance*, Inst. of Gov. Studies Press (Berkeley), 1993.
[55] Robert Bernstein, "Modeling Personal Lines Automobile Insurance in California: Development and Application of a Pay-at-the-Pump Proposal," *Journal of Insurance Regulation*, Vol. 13, No. 1, 1994.
[56] Wenzel, 1995, p. 29.

problem with PATP is the ease with which motorists can evade the surcharge by purchasing fuel in other jurisdictions or illegally using untaxed gasoline, as discussed in Appendix 3. This reduces tax revenue and employment within jurisdictions with PATP, and results in a cross-subsidy from those who pay the surcharge to drivers who evade it.

B. Price Structure

Total insurance payments average about $700 annually per vehicle, and a typical automobile consumes about 600 gallons of fuel annually. Funding total insurance at the pump therefore requires surcharges of about 86¢ per gallon. However, only about 55% of total premiums are for mandatory coverage. Most PATP proposals have 25-45% of revenue from non-fuel surcharges in order to incorporate various risk factors. These include annual license surcharges for high-risk drivers, vehicle registration surcharges that reflect crash cost factors that vary by vehicle type, and traffic violation surcharges.

Since it only covers 55% of total insurance, and 25-45% of funding is raised through non-fuel charges, only 30-45% of total insurance payments would be paid at the pump, requiring fuel surcharges of 25-40¢ per gallon, averaging 1.1-2.0¢ per mile, representing a 17-27% increase in fuel prices. Fuel supply is somewhat elastic, so fuel producers and distributors might absorb a portion of the surcharge, although this effect is small if prices increase in just one geographic region.

Increased fuel prices encourage motorists to choose more fuel-efficient vehicles. The current vehicle fleet is particularly inefficient compared with its technical potential, and real fuel prices are likely to begin to increase in the future due to market trends, in addition to any PATP surcharge.[57] As a result, fuel surcharges would need to increase regularly to maintain constant revenue per mile driven. For example, a 35¢ per gallon surcharge is likely to increase average long-run vehicle fuel efficiency by about 10%. The surcharge would need to increase to 38¢ per gallon to maintain constant revenue per mile driven, in addition to price increases needed for general inflation. This could be regressive because lower income motorists tend to own older vehicles, and so would lag in their ability to choose fuel-efficient models.

C. Market Penetration

PATP is applied to all mandatory vehicle insurance coverage for gasoline-powered vehicles, representing about 90% of all vehicle mileage and 50% of total insurance premiums. Only 30-45% of total insurance is distance-based since most PATP programs include vehicle registration and licensing surcharges based on other risk factors.

D. History Of This Concept

PATP has been promoted by many experts and interest groups as part of comprehensive insurance reform (usually with some form of no-fault insurance), as a way to minimize

[57] L.B. Magoon, *Are We Running Out of Oil?*, US. Geological Survey (http://geopubs.wr.usgs.gov/open-file/of00-320), 2000.

uninsured driving, and as an energy conservation strategy. It has not been implemented, with the exception of a minimal-coverage accident compensation fund in South Africa.[58]

E. Actuarial Accuracy

PATP is not actuarially accurate since drivers pay for insurance according to their fuel consumption rates rather than risk factors. Table 9 describes factors affecting fuel consumption. Most PATP proposals include surcharges on vehicle registration, drivers licenses and traffic citations to represent risk factors (crash history, vehicle type, etc.), but these are not distance-based.

Table 9 **Factors Affecting Fuel Consumption[59]**

Factor	Reason	Impact on Fuel Efficiency	Groups Overpaying Under PATP
Vehicle's rated fuel efficiency	Engine size and type; vehicle weight.	Can vary more than 300%.	Drivers with heavier vehicles.
Temperature	Engines are inefficient while operating in colder temperatures.	Fuel consumption increases by 8% and 30% at 0°C and -30°C, respectively.	Drivers in colder regions.
Road conditions	Rough road surfaces increase resistance and fuel consumption.	Increases fuel consumption by up to 35% over driving on smooth road surfaces.	Drivers in communities with poor road conditions.
Vehicle age and maintenance	Vehicles that are old or poorly maintained are less fuel-efficient.	Out of tune engines, wheel misalignment, under/over inflated tires, etc. can increase fuel consumption 15%+.	Drivers of older or poorly maintained vehicles.
Speed	Higher vehicle speeds increase fuel consumption.	Vehicles typically use 20% more fuel if driven at 65 mph instead of 55 mph, for example.	Higher speed drivers.
Traffic congestion	'Stop and go' traffic increases individual fuel consumption	City driving can increase fuel consumption by 55% compared with highway driving.	Motorists who drive in congested conditions.
Ice and snow	Ice and snow increase wheel slippage and resistance.	?	Motorists in cold climates.
Topography	More fuel required to climb hills	?	Drivers in hilly or mountainous areas.
Vehicle load.	Increases total vehicle weight	?	High occupancy or heavy cargo vehicles.

This table summarizes factors that affect fuel consumption rates and therefore PATP surcharges.

F. Implementation Requirements

PATP implementation requires:

- Passing legislation to establishes the program.
- Determine total revenue required and develop a fee structure.

[58] Multilateral Motor Vehicle Accidents Fund Act 93 of 1989, South Africa (gopher://gopher.polity.org.za:70/00/govdocs/white_paper/Notice96.705).
[59] NRCan, *1998 Fuel Consumption Guide: Ratings for New Cars, Pickup Trucks and Vans*, Natural Resources Canada (Ottawa), 1998.

- Establish a schedule for changing over to the new system in such a way that insurance coverage is continuous, that there is no unnecessary duplication of coverage.
- Reorganize insurance activities as needed to function under the new system.

Surcharge collection costs should be minimal since governments already collect fuel taxes. There may be additional law enforcement costs to deal with increased fuel fraud. Border congestion may increase in some areas.

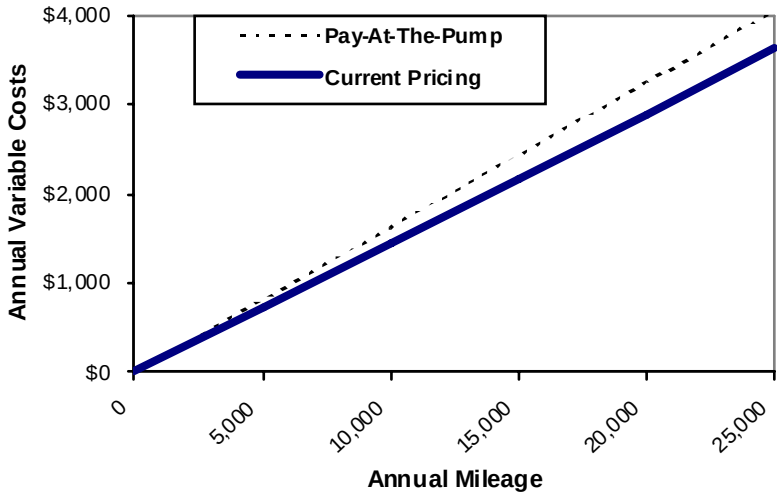
G. Travel Impacts

A 35¢ per gallon surcharge would increase gasoline prices about 25% (assuming $1.50 per gallon fuel prices). This is estimated to reduce long-run vehicle travel by 5-8%, based on a –0.2 to –0.3 elasticity of vehicle travel with respect to fuel price, as discussed in Appendix 1. However, actual vehicle travel reductions are likely to be low because:

- Cross-border and illegal fuel sales are expected to increase to 7-12% of total gasoline sales.
- Fuel intensive motorists may shift to alternative fuels.[60]
- Distributors might absorb a portion of the price increase due to market competition.
- The fuel taxes and fees may not be raised over time as much as would otherwise occur due to political concerns about the province's relatively high fuel prices.

Figure 20 illustrates the increase in perceived variable vehicle costs.

Figure 20 **PATP Impact on Variable Costs**



PATP has moderate price impacts that are expected to reduce driving by 5-6%.

[60] Conversion to CNG would be repaid in 2-3 years, and shifts to diesel when purchasing a new vehicle could have even shorter paybacks.

H. Equity

The equity impacts of PATP have been widely debated.[61] PATP replaces current inequities (lower-mileage drivers subsidize insurance costs of higher-mileage drivers in each rate class) with other inequities (lower risk drivers of fuel inefficient vehicles subsidizing higher-risk drivers of fuel-efficient vehicles).

Assuming a 35¢ per gallon surcharge, a vehicle getting 35 mpg pays 1.0¢ per mile, while one that gets 14 mpg pays 2.5¢ per mile. Since this fee is not related to risk, safer drivers overpay while higher risk drivers underpay their insurance costs. The absolute amount of under- or over-payment depends on a vehicle's total mileage. A low-risk driver with a fuel-inefficient car who overpays by 1¢ per mile would overpay $60 annually if she drives 6,000 miles annually, and $180 annually if she drives 18,000 miles. Most PATP proposals include vehicle registration and drivers license surcharges based on risk factors, which increase actuarial accuracy but reduce the portion of premiums that are distance-based.

Most low-income motorists would probably save money with PATP, since they drive their vehicles less than average, but it tends to overcharge rural residents, who have lower insurance rates and drive high mileage. PATP may become more regressive over time if higher-income households purchase more fuel-efficient vehicles than lower-income households. PATP would virtually eliminate uninsured driving, which is horizontally inequitable. However, this would probably be offset many times over by drivers who underpay their insurance costs by purchasing fuel in other jurisdictions or illegally yet still receive coverage. This is predicted to represent 5-10% of total provincial travel, an order of magnitude greater than current uninsured driving (Appendix 3).

One study concludes that PATP increases both horizontal and vertical equity compared with current insurance pricing, but acknowledges it is not optimal.[62] Another study finds that low-income motorists would enjoy direct benefits worth $4-150 per vehicle-year, while highest income motorists ($60,000+) experienced net welfare losses of $25-145.[63]

Bordoff and Noel estimate that in the U.S., lower-annual-mileage motorists overpay an average of $318 annually compared with what is actuarially accurate, and PAYD would provide direct net savings to about two-thirds of all motorists.[64] Ferreira and Minike conclude that PAYD would certainly increase horizontal equity and probably increase vertical equity (benefit lower-income people).[65]

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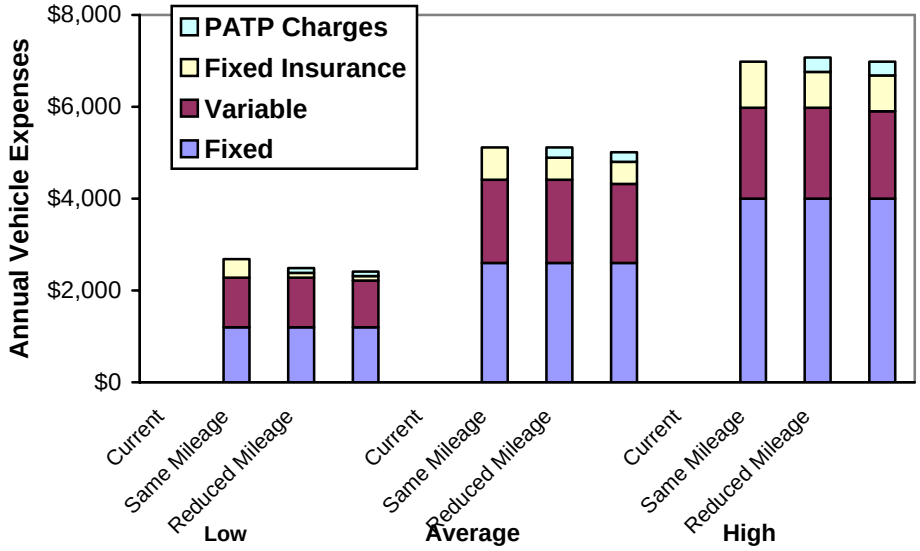
[61] Rayola Dougher and Thomas Hogarty, *Paying for Automobile Insurance at the Pump: A Critical Review*, Research Study #076, API (www.api.org), 1994; Wenzel, 1995.
[62] Jeff Allen, Roland Hwang and Jane Kelly (2004), *An Equity Analysis of Pay-as-you-Drive Insurance in California*, Union of Concerned Scientists (Berkeley; www.ucs.org).
[63] Chris Kavalec and James Woods, *Toward Marginal Cost Pricing of Accident Risk: The Energy, Travel and Welfare Impacts of Pay-at-the-Pump Insurance*, California Energy Commission (Sacramento), 1998.
[64] Bordoff and Noel 2008.
[65] Ferreira and Minike 2010.

I. Consumer Impacts

Motorists with fuel-efficient vehicles, who drive less than average, and who evade the surcharge by buying fuel in other jurisdictions or illegally, would save money. Those who have fuel inefficient vehicles, drive more than average, and cannot evade the surcharge would tend to pay more. Transaction costs would not significantly decline since motorists would still pay annual vehicle registration fees, and most would purchase other forms of vehicle insurance as they do now.

Figure 21 **Current and PATP Costs Compared**



This illustrates how PATP affects total vehicle costs. "Current" refers to existing fixed-rate insurance pricing. "Same Mileage" refers to PATP with no reduction in annual mileage. "Reduced Mileage" assumes a 5% mileage reduction. Low mileage vehicles save while high-mileage vehicles pay more. Average vehicles experience no change if mileage does not change, but save if vehicle travel declines as expected.

Figure 21 illustrates how PATP affects motorists' costs. A low-cost vehicle driven 6,000 miles annually saves $195 per year, a 7.3% reduction in total vehicle expenses. If vehicle mileage declines by as expected, savings increase to $201 per year, a 7.5% reduction in vehicle expenses. An average vehicle driven 12,500 miles experiences no change, and an $11 savings if mileage declines 5%. A vehicle driven 18,000 miles annually pays $96 more, a 1.4% increase in total vehicle expenses, or slightly less if mileage declines as expected. Table 10 summarizes these impacts.

Table 10 **PATP Consumer Cost Impacts**

Vehicle	If Vehicle Use is Unchanged	If Vehicle Use Declines 5%
Low (6,000 miles/yr)	-$195 (-7.3%)	-$201 (-7.5%)
Medium (12,500 miles/yr)	$0	-$11 (-0.2%)
High (18,000 miles/yr)	$96 (1.4%)	$84 (1.2%)

(Percentages in parenthesis indicate insurance cost changes relative to total vehicle costs.)

J. Public Acceptability and Marketing

PATP has frequently been proposed but never implemented. Many articles and reports have been published supporting or opposing PATP. Supporters include consumer groups advocating comprehensive insurance reform, people concerned with uninsured driving, and environmentalists supporting fuel conservation. Opponents tend to represent petroleum and insurance industries, fuel-intensive vehicle users, and the legal profession when PATP is proposed in conjunction with no-fault reform.[66]

Consumers appear to be highly sensitive to fuel prices, making increases in fuel charges politically difficult. A focus group of public attitudes toward various insurance price reforms concluded, "*Paying at the pump was not received with much enthusiasm. The immediate reaction of most participants was that an indeterminate amount of taxes were already collected at the pump and were perceived to disappear into government general revenue without any significant improvement to the transportation system.*"[67] Participants appear to consider PATP a new tax rather than a way to pay for vehicle insurance.

K. Crashes

Some experts argue that PATP would cause motorist to drive smaller cars that provide less occupant protection, but others refute this, claiming that fuel-efficient vehicles do not necessarily provide less protection and fuel-efficient vehicles impose less risk to other road users.[68] To account for these factors this analysis uses a somewhat smaller estimate of crash reductions than applied to other distance-based pricing options. It estimates that PATP would reduce crashes by 5.0%.

L. Energy Use and Emissions

A 35¢ per gallon insurance surcharge would reduce fuel consumption by an estimated 16%.[69] Two thirds of this reduction would result from more fuel-efficient vehicles and one third from reduced travel. Actual fuel reductions would probably be smaller, perhaps closer to 14%, because various types of fuel purchases not affected.

Carbon emissions would decline in proportion to reductions in fuel consumption. Other emissions should decline in closer proportion to reductions in vehicle travel. Shifts to alternative fuels would reduce some emissions, but shifts to diesel could increase emissions of particulates and SOx.

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[66] Wenzel, 1995, appendix B.
[67] Viewpoints Research, *Travel Demand Management: A Qualitative Analysis of Public Views*, Survey 30, BCTFA/GVRD, March 1996 DRAFT.
[68] J. Daniel Khazzoom, "Impact of Pay-at-the-Pump on Safety Through Enhanced Vehicle Fuel Efficiency," *Energy Journal*, Vol. 18, No. 3, July 1997, pp. 103-133; Marc Ross and Tom Wenzel, *Losing Weight to Save Lives: A Review of the Role of Automobile Weight and Size in Traffic Fatalities*, ACEEE (www.aceee.org), 2001.
[69] Based on a –0.7 elasticity of fuel consumption with respect to fuel price, as discussed in Appendix 1.

M. Economic Efficiency and Development

Some businesses would pay more under PATP, although most that would face significant cost increases would probably shift to alternative fuels (diesel, CNG, etc.). The moderate reduction in travel should provide modest productivity benefits from reduced congestion delays, facility expenses, crashes and pollution damages.

PATP could impose significant economic costs by encouraging drivers to purchase fuel in other jurisdictions and illegally. PATP might also discourage tourism. Although these are economic transfers (fuel dealers and government coffers in other jurisdictions would benefit) they could have significant economic impacts in an area.

N. Summary of Advantages and Disadvantages

Advantages

- Relatively easy to implement.
- May reduce some transaction costs, but probably not much, since motorists still need to register their vehicles, and most need to purchase optional types of coverage.
- Large energy conservation impacts.
- Eliminates uninsured driving.

Disadvantages

- Only a minor portion of total vehicle insurance becomes distance-based.
- Travel impacts and related benefits are modest.
- No significant equity benefit. Replaces current inequities with new inequities (overcharges lower-risk drivers with fuel inefficient vehicles, and rural motorists).
- Is likely to cause significant leakage of fuel sales across borders and to illegal fuel purchases.

3. Usage-Based Premiums

The unit used to measure exposure is changed from the vehicle-year to the vehicle-mile or vehicle-operating-hour. Other rating factors are incorporated into this unit.

A. How It Works[70]

With this system, the unit of exposure used to calculate vehicle insurance premiums is *cents-per-vehicle-mile* rather than *dollars-per-vehicle-year*. Other rating factors are incorporated into this price unit so higher-risk vehicles pay more per mile than lower-risk vehicles. "Odometer audits" performed at the beginning and end of the policy term are used to collect accurate mileage data. Odometer auditing is described briefly below and in detail in Appendix 4.

A variation is to use *minutes-of-vehicle-operation* as the unit of exposure, based on data collected by a small electronic meter called a *Vehicle Use Detector And Recorder* (VUDAR) installed in a vehicle's engine compartment.[71] This equipment is estimated to cost $20-30 per unit, with a 2-year operating life. Installation and data downloading would be performed at the beginning and end of the policy term, similar to odometer audits. The Progressive Insurance Company has a patient on the use of in-vehicle instrumentation for insurance pricing that may apply to VUDAR.[72] Total annualized incremental costs for equipment, installation and data downloading are estimated at $20-40, plus any royalty payments.

Except for the pricing unit and the need for odometer audits or VUDAR data collection there would be minimal changes in the relationships between vehicle owners, brokers and insurance companies.

Usage-Based Premiums could be implemented as a consumer option.[73] Vehicle owners would choose whether to pay by the vehicle-year, vehicle-mile or vehicle-minute, just as consumers are able to choose various telephone and internet service rate options.

With additional equipment, this pricing system could allow different drivers to be charged different insurance rates. Each driver would insert a unique card or code into an optional electronic meter. For example, a teenage male could be charged a higher rate per mile or minute than his mother or farther when driving a family car.

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[70] Patrick Butler, *Operation of an Audited-Mile/Year Automobile Insurance System Under Pennsylvania Law*, National Organization for Women (www.now.org), 1992; Todd Litman, "Distance Based Vehicle Insurance as a TDM Strategy," *Transportation Quarterly*, Vo. 51, No. 3, Summer 1997, pp. 119-138, also available at www.vtpi.org; Dean Baker and Jim Barrett, *The Feasibility of Pay by the Mile Automobile Insurance*, Economic Policy Institute (www.epinet.org), 1998; Aaron S. Edlin (2003), "Per-Mile Premiums for Auto Insurance," *Economics for an Imperfect World: Essays In Honor of Joseph Stiglitz*, MIT Press; at: http://works.bepress.com/aaron_edlin/28.

[71] VUDAR is designed by Westfields Software, Ltd. of Vancouver, BC, contact: Rmyrtle@Canada.com.

[72] U.S. patent number 5,797,134 (www.delphion.com/details?&pn=US05797134__).

[73] *Per Mile Auto Insurance Option Act*, National Organization for Women (Washington DC; www.now.org/issues/economic/insurance), March 1998.

Odometer Auditing (For more information see appendices 4)
Odometer auditing is a system to collect accurate mileage data. Audits would be performed for a fee when a vehicle's insurance is renewed. They involve five steps:

1. Check speedometer and instrument cluster for indications of tampering.
2. Attach a small seal to the ends of mechanical odometer cables to indicate if it is disconnected. This is unnecessary on most newer vehicles that have electronic speedometers integrated with the vehicle's engine computer.
3. Record tire size and check that it is within the specified range.
4. Check odometer accuracy and calibrate with a dynamometer. This step is optional and could be performed on a spot-check basis.
5. Record odometer reading and send results electronically to the vehicle licensing agency.

Audits typically require 5 to 10 minutes, and less if performed with other vehicle servicing, such as an oil change or emissions check. Assuming mechanics' chargeout rates average $60 per hour, audits would cost $5-10 or less.[74] Odometer auditors would typically be existing vehicle service businesses, emission inspection stations, and perhaps some insurance brokers. Certifying a large number of businesses would result in a competitive market with low fees.

Individual insurance companies, insurance industry organizations, consumer organizations or government agencies could certify auditors. Data collected during odometer audits would be incorporated electronically into vehicle registration or insurance company databases. The certification program would include developing practices and standards, training, testing and monitoring of odometer auditors, with activities to discourage, identify and prosecute any auditors who engage in fraud. An auditor certification program could be self-supporting with costs recouped through an annual fee per audit station. A typical station would perform 5,000-10,000 audits annually at $6 each, earning $25,000-100,000 per year.

For more frequent mileage-based billing, customers could self-report odometer readings and corresponding mileage and be billed quarterly or more often. These self-reported odometer readings would be confirmed annually by odometer auditors. Most new automobiles have engine computers and an increasing portion have cellular telephones. It is relatively easy to integrate these systems for automatic odometer data reporting to a central computer that would generate a monthly or bi-monthly insurance bill.

Odometer auditing would provide several supplementary benefits. Vehicle mileage information is valuable to used vehicle buyers,[75] and transportation researchers. It would also allow other vehicle charges, such as registration fees and emission charges, to be distance-based and therefore more equitable and economically efficient.

[74] This estimate is consistent with other vehicle servicing fees. For example, emission inspections require significantly more time and equipment, and typically cost $10-20 each.
[75] Various services charge $10-20 to provide a particular vehicle's ownership and repair history.

Odometer Fraud

There are concerns that odometer fraud could become a significant problem with Per-Mile Pricing. There are several ways to make odometers under-record (see Appendix 4), but most can be identified during odometer audits and crash investigations. Vehicle manufactures produce increasingly tamper-resistant odometers since leasing, warranty transactions and used vehicle sales are based on mileage readings. Government agencies are also interested in odometer accuracy for legal and safety reasons, resulting in policies to discourage such fraud, including the 1986 Truth in Mileage Act (US Public Law 99-576), which establishes odometer disclosure procedures and enforcement standards.

Some vehicle dealers hire specialists ("clockers") to roll back odometers before reselling late-model, high-mileage vehicles, to increase their value by $2,000-4,000. One study estimate a 3.5% chance of odometer rollback during an average vehicle's eleven-year operating life, or about 3 per 1,000 annually.[76]

Per-Mile Premiums should have modest fraud rates because:

- Odometers are increasingly tamper-resistant. Most new vehicles have electronic-digital odometers that cannot be reset. Some also have mileage data recorded in engine computers that can be checked to verify odometer readings. Since newer vehicles tend to be driven most, the vehicles with the greatest incentive for fraud have the most tamper-resistant odometers.
- Regular auditing and checking for signs of fraud during crash inspection can identify most types of tampering. For this reason, the Independent Used Car Dealers have asked that odometer readings be recorded during vehicle registrations.[77]
- Most individual motorists would have a relatively small incentive for fraud. Most could only save $300-600, a tenth of what vehicle dealers typically gain. Average households could save more by bypassing their electric meters than by odometer tampering, yet few do.
- Most vehicle owners lack ready access to "clockers." Amateurs often damage equipment or leave marks, resulting in high costs and penalties. Clockers could not advertise their services without being caught. Odometer fraud penalties are severe and could be increased if needed.
- Evidence of tampering would void insurance. This would discourage odometer fraud and reduce insurers' financial exposure when fraud occurs.
- Annual odometer audits would leave a record in the vehicle registration database that would indicate discrepancies, making tampering easy to spot. This should virtually eliminate odometer fraud by vehicle dealers, resulting in an overall reduction in total odometer fraud.

For these reasons, fraud rates are expected to be low. Even if 2% of motorists alter their odometers to disguise half their true mileage driven each year, only 1% of insurance charges would be "stolen," a theft rate comparable to other consumer goods. Odometer auditing should provide data comparable in accuracy to what is used in other common commercial transactions, and more accurate than self-reported data now used by insurers.

[76] NHTSA, *The Incidence Rate of Odometer Fraud: Preliminary Report*, DOT HS 809 441, National Highway Traffic Safety Administration (www.nhtsa.dot), 2002.
[77] Ed Hendricks, President, "Odometer Readings," Automobile Retailers Association, Used Car Division, letter sent to ICBC 11 June 1997.

B. Price Structure

Per-Mile Premiums

Per-Mile Premiums would be calculated by dividing current annual premiums by average annual miles of travel for each vehicle class. Table 11 indicates the fee based on current annual premiums and mileage. Since vehicle insurance premiums average about $700 per vehicle-year and vehicles average about 12,500 annual miles, the overall average fee would be about 5.6¢ per mile. Once this system is established there would be minimal cost to incorporating other vehicle charges.[78] For example, vehicle registration fees could also be distance-based, adding another 1.2¢ per mile, on average, to variable costs.

Table 11 **Examples of Per-Mile Premiums**

Current Annual Premium	Annual Miles Driven By Vehicle Class				
	7,500	10,000	12,500	15,000	17,500
$300	$0.040	$0.030	$0.024	$0.020	$0.017
$400	$0.053	$0.040	$0.032	$0.027	$0.023
$500	$0.067	$0.050	$0.040	$0.033	$0.029
$600	$0.080	$0.060	$0.048	$0.040	$0.034
$700	$0.093	$0.070	$0.056	$0.047	$0.040
$800	$0.107	$0.080	$0.064	$0.053	$0.046
$900	$0.120	$0.090	$0.072	$0.060	$0.051
$1,000	$0.133	$0.100	$0.080	$0.067	$0.057

This table illustrates per-mile insurance fees.

Per-Minute Premiums

Since a typical vehicle is driven about an hour a day or 22,000 minutes annually, an average motorist would pay about 4.5¢ per minute. Rates could vary by time of day or week, such as higher rates during rush hour or at night. Other rating factors would be incorporated into this unit, so a higher-risk motorist would pay more and a lower-risk motorist would pay less per minute.

Data described earlier in this report indicate that per-mile crash rates decline in the higher annual mileage classes. This implies that actuarially accurate pricing should have declining block rates (e.g., 5¢/mile for the first 10k miles, 4¢/mile for 10-20k miles, 3¢/mile for 20-30k miles, etc.). However, as previously discussed, these data reflect differences between vehicles and do not necessarily reflect the effects of mileage reductions by individual vehicles. Also, optimal crash costs are usually higher than insurance compensation costs, because most crashes involve multiple vehicles (so each additional vehicle on the roadway both bears and imposes crash risk), and because many crash costs are uncompensated.[79] A flat block rate is simplest to use and provides greater

[78] Todd Litman, *Distance-Based Charges; A Practical Strategy for More Optimal Pricing*, VTPI (www.vtpi.org), presented at the Transportation Research Board Annual Meeting, January 1999.
[79] William Vickrey, "Automobile Accidents, Tort Law, Externalities, and Insurance: An Economist's Critique," *Law and Contemporary Problems*, Vol. 33, 1968, pp. 464-487, available at www.vtpi.org/vic_acc.pdf.

safety and TDM benefits than declining block rates, since it gives most motorists a greater incentive to reduce mileage. Table 12 illustrates such a flat block rate.

Table 12 **Per-Mile Premiums for Selected Rate Classes**

	Pleasure Urban Core	Pleasure Urban Fringe	Work Other Areas	Work Urban Core	Work Urban Fringe	Business Other Areas	Business Urban Core	Business Urban Fringe
Low-risk	$0.020	$0.016	$0.013	$0.027	$0.016	$0.016	$0.026	$0.017
High-risk	$0.125	$0.094	$0.107	$0.111	$0.087	$0.088	$0.108	$0.088

This table illustrates examples of actuarially accurate Per-Mile Premiums based on current vehicle-year premiums divided by average annual mileage.

Motorists would prepay for the miles/minutes they expect to drive during the term, either in a lump sum or in several payments. For example, some motorists might pay for 12,500 miles at the start of the term, while others might pay for just 5,000 miles at first and make additional payments as needed. There are three possible approaches to coverage:

- *Coverage only on prepaid miles/minutes.* For example, if a vehicle owner pays for 5,000 miles and has a claim 5,001 miles later, they receive no coverage. This is the simplest approach and would be appropriate for optional coverages, but if applied to mandatory liability coverage it would result in uninsured driving.
- *Coverage regardless of prepayment.* Once a driver makes a minimum payment they have coverage for the policy term (usually a year), and would pay for any outstanding miles or minutes at the end of the term. For example, at the start of the term a motorist might pay for 5,000 miles of coverage but drive 15,000 miles. At the end of the term they would need to pay for the outstanding 10,000 miles driven, plus 5,000 miles for the next term in order to obtain vehicle license tabs. Insurance companies could charge extra for post-payment of miles to recover investment revenue foregone. A problem with this approach is that some motorists might avoid full payment by selling a vehicle outside the jurisdiction, or scrapped it at the end of their term.
- *Coverage regardless of prepayment, with late payment penalties*. This combines options A and B. Basic liability coverage would be provided for all travel during the policy term, but claims on unpaid miles or minutes would have financial penalties. For example, deductibles could double or triple for claims that occur past the prepaid number of miles. This would give motorists an incentive to prepay, and would reduce insurance company's losses, since drivers who intend to avoid full payment would be stealing low value coverage.

At the end of the term the odometer is audited again or VUDAR data is downloaded, and the premium calculated. Vehicle owners are credited for unused miles/minutes, or pay any outstanding balance, like other utilities, and pay the next term's coverage.

Another approach is to have motorists pay a normal premium but receive a rebated against their next year's insurance for lower than average mileage. Odometer audits would be optional (no audit, no rebate). The cost of the audits could be initially paid for by the insurance company but subtracted from the rebate (if any), so there is no risk to the consumer. A disadvantage with this system is that it provides no incentive for motorists who drive more than average in a year to reduce their mileage.

C. Market Penetration

Usage-Based Premiums could be mandated for all vehicle insurance or implemented as a consumer option, with motorists allowed to choose their rate structure as consumers now do for telephone and Internet service. Data described earlier in this report indicates that Usage-Based Premiums are justified for virtually all types of coverage. Rates for taxis and some commercial fleets already reflect their high annual mileage and so might not be affected by Usage-Based Premiums.

Optional Usage-Based Premiums would tend to attract most motorists who drive less than average, and so would save money. If no cross-subsidies are allowed between the insurance pools the cost of vehicle-year premiums will increase over time as this pool looses subsidies from lower-mileage motorists.[80] Over time the annual mileage at which Usage-Based Premiums is financially attractive will increase. Optional Per-Mile Premiums are expected to attract 25-50% of policies during the first few years, assuming that most motorists who expect to save $50 or more annually would choose it, with penetration increasing over time. Per-Minute Premiums would have somewhat lower (perhaps half) penetration due to additional equipment costs.

D. History of This Concept

In the 1960s, Noble Prizewinner William Vickrey criticized fixed-price insurance as being unfair and inefficient, and proposed distance-based pricing.[81] The National Organization for Women has promoted Usage-Based Premiums for more than a decade on equity grounds.[82] It has been promoted as a transportation demand management strategy.[83] A 1998 conference, *Clean Insurance; The Benefits of Mileage Based Auto Insurance Policies* explored its feasibility, benefits and costs.[84] It has been endorsed by environmental organizations.[85]

A report on potential vehicle air emission reduction strategies for the BC government identified Per-Mile Premiums as promising.[86] Legislation has been introduced in several jurisdictions to require optional Usage-Based Premiums, although none has passed.[87] Bill 3871 introduced in the 2001 Oregon legislature would provide tax credits to insurers that offer "pay as you drive" pricing. It is endorsed by the National Association of Independent Insurers, regional governments, the Oregon/Idaho chapter of the American Automobile Association, the Oregon Consumer League, environmental organizations, citizen transportation reform groups and the Interfaith Global Warming Campaign.[88]

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[80] Baker and Barrett, 1998, p. 4.
[81] Vickrey, 1968.
[82] Butler, 1992.
[83] Litman, 1997.
[84] Sponsored by the Economic Policy Institute (www.epinet.org), in Washington DC.
[85] NEW, *This Place On Earth 2001*, Northwest Environment Watch (www.northwestwatch.org), 2001.
[86] Dan Perrin, *Options to Reduce Light Duty Vehicle Emissions in British Columbia*, Discussion Paper, BC Ministry of Finance and Corporate Relations (www.fin.gov.bc.ca/tbs/emissions.htm), 2000.
[87] Insurance Program, National Organization for Women (www.now.org).
[88] Oregon HB 3871 www.leg.state.or.us/01reg/measures/hb3800.dir/hb3871.intro.html. Information from Christine Hagerbaumer of the Oregon Environmental Council (www.orcouncil.org), May 2001.

Texas House Bill 45, passed in 2001, gives insurers permission to offer cents-per-mile pricing for vehicle insurance (www.capitol.state.tx.us). Companies may begin offering this price option in January, 2002. It also requires insurance companies to separately track and report the claim losses and premium revenues for mileage-based and time-based premiums. Below is a press release by the Texas National Organization for Women, which lobbied for the bill.

Statement by Deborah Bell, President, Texas National Organization for Women
For Information Contact Patrick Butler, Insurance Project, 512-695-5136
September, 2001

New "cents-per-mile" car insurance law could end overcharging and redlining

Texas National Organization for Women (NOW) congratulates the Texas Legislature for passing the "cents-per-mile" car insurance bill—House Bill 45—signed into law by Governor Rick Perry. By adopting legislation NOW developed, lawmakers have taken a major step toward 1) making compulsory insurance work, 2) eliminating redlining and the stigma it creates, and 3) ending overcharging to insure cars driven less than average. The new option to buy miles of protection as needed (added to the odometer reading at a cents-per-mile rate) will enable a car owner for the first time to individually control insurance cost by the amount the car is used.

The law as passed gives insurers permission to offer the cents-per-mile option to whomever they wish. Texans should now demand that their insurers make this option available to every one of their insureds. We need the per-mile alternative to fixed dollars-per-year prices that are forcing millions of cars to go uninsured. For example, owners of cars in a certain insurance price class—based on territory, car use and type, and driver type—now paying $500 per year in fixed installments could be offered the option of buying miles as needed at 5.0 cents per mile.

Compulsory insurance seems to work in upper-income zip codes where most people can afford to keep insurance on cars driven less than average. Because these cars cost insurers proportionately less in claims, they bring in extra profits and insurers privately call landing their business "skimming the cream."* Insurers use extra profits from "cream" customers to compete by holding car insurance prices down for their preferred customers who have many other insurance needs. Customers typically skimmed and overcharged are those who commute by carpool, bus or bicycle, and also women, older people, and households with more cars than drivers.

In low income zip codes, insurers redline many cars to higher "nonstandard" prices—not because their drivers are less careful, as insurers encourage everyone to believe—but because of the scarcity of "cream" to hold prices down. What really happens is that miles, costs, and insurance prices (per car) spiral up where high insurance cost and strong enforcement increase the incentive for ever more drivers to share fewer insured cars.

The new law directs the Insurance Commissioner to adopt by year's end the few regulations needed (e.g., adding to the car's ID card the odometer reading at which insurance expires unless more miles are bought). Companies may begin insuring under the option January 1, 2002. But if they then choose to withhold the option in order to protect their extra profits from insuring little-used cars, newly informed consumers can step up their demand for cents-per-mile rates and even turn to the Legislature to compel companies to offer it. That is only reasonable in view of the fact that the Legislature compels Texans to buy insurance on motor vehicles regardless of how little they are driven, if at all.

E. Actuarial Accuracy

Usage-Based Premiums can incorporate virtually any existing rating factor and would be significantly more accurate than current pricing, Mileage Rate Factor, or PATP. As insurers gain experience they will be able to develop increasingly accurate rate structures.

Because traffic congestion tends to increase crash frequency and reduce traffic speeds, flat Per-Minute Premiums (i.e., unaffected by when driving occurs) may be slightly more actuarially accurate than Per-Mile Premiums, but this is speculative, since it may be offset by other driving conditions with a positive relationship between speed and crashes. Variable Per-Minute Premiums, with higher rates during higher risk times, would probably increase accuracy, although experience is needed to determine how much.

F. Implementation Requirements

The specific steps needed to implement Usage-Based Premiums are detailed below.

1. *Establish odometer auditor or VUDAR installation certification.* Private insurers or a government agency would establish a certification program, including training, testing, monitoring, and fraud investigation.
2. *Establish data management.* Develop a method to collect data from auditors and incorporate it into the vehicle registration database.
3. *Develop rate structure.* Develop rules for using the new pricing system and calculate rates.

It may be preferable to begin with a pilot project to gain experience with this pricing option. An insurer could certify 5-10 odometer auditors in a particular area and offer Per-Mile Premium pricing to 1,000 or so motorists located in the region. If no major problems are found, the number of auditors and participants could be increased each subsequent year until Per-Mile Premiums are offered as an option to all motorists.

Transition Costs

Implementation requires development and publication of a completely new rate plan and updating the vehicle registration database to incorporate mileage data. An optional system could require marketing to encourage motorists to choose this option. Implementing Per-Minute Premiums would be similar to Per-Mile Premiums, with additional costs to develop VUDAR equipment and data collection methods.

Transaction Costs

There should be minimal on-going incremental costs to insurers since odometer auditing or VUDAR system costs would be self-funded through user fees. The incremental cost of odometer auditing is estimated at $5 per vehicle-year, and a VUDAR system at $30 per vehicle-year, plus any royalty payments. There may be additional costs for odometer fraud investigations, offset by any fines levied against violators.

Financial Risk

Insurers face potential financial risks if crashes decline less than vehicle travel, resulting in a greater reduction in premium revenue. Although the exact financial impacts are uncertain, available evidence indicates that crashes and claims should decline more than premium revenue, for reasons described earlier.

Motorists in multi-vehicle households that insure a vehicle with Usage-Based Premiums may shift driving, and therefore crash risk, to their other vehicles with fixed-rate pricing.

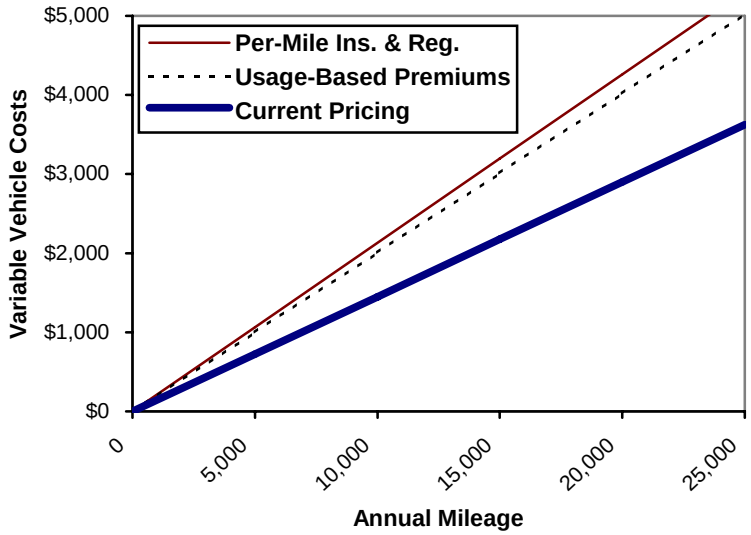
Insurers could anticipate such shifting by requiring all vehicles in a household to have the same pricing, or by charging an extra fee on fixed-mileage insurance if other household vehicles are priced with Per-Mile Premiums.

If Usage-Based Premiums is optional there is a risk of adverse selection if it tends to attract motorists with higher per-mile crash rates.[89] If that occurs, the per-mile fee would need to be higher than calculated by simply dividing current premiums by average mileage or minutes for each price category. Such risks can be minimized by beginning with small pilot projects to gain experience with these pricing options and develop appropriate rates.

G. Travel Impacts

Usage-Based Premiums would provide a significant new incentive to reduce driving. An average premium of 5.6¢ per mile is equivalent to a $1.20 per gallon increase in fuel prices, or $1.36 if vehicle registration fees also become distance-based. This represents a 40-50% increase in a typical automobile's operating costs, as illustrated in Figure 22. Mandatory Usage-Based Premiums applied to all motorists is predicted to reduce total vehicle mileage about 10%, or 12% if registration fees also become distance-based (see Appendix 1 for travel elasticity data). Travel reductions might be increased if marketing emphasize potential consumer savings from travel reductions and generally encourage motorists to reduce their mileage.

Figure 22 **Per-Mile Premiums Impact on Variable**



This figure illustrates how the perceived variable cost of driving increases with Usage-Based Premiums.

Optional distance-based pricing would tend to attract lower-mileage motorists, since they would expect direct financial savings. Motorists who drive less than 12,500 miles per year (the current average) as a group average about 7,000 annual miles, which is used for

[89] Edlin, 2003.

analysis in this study. Motorists who would choose optional Per-Minute Pricing would tend to have even lower annual mileage (this analysis assumes 6,000 annual miles) due to the additional equipment costs. Optional distance-based pricing is also likely to attract motorists who are relatively price sensitive. For this analysis we assume that Optional Per-Mile Premiums would result in a 13% mileage reduction per participating motorist, and Per-Minute Premiums would result in a 14% mileage reduction.

Some people suggest that standard Per-Mile Premiums may have little impact on travel because the fee is collected infrequently. Premiums would be set annually, resulting in several months average delay between a reduction in mileage and financial savings (although electronic payment systems may allow more frequent billing in the future). However, it is not clear what affect payment frequency actually has on price elasticity. For example, there is no evidence that households that heat with oil, coal and wood, and so pay for space heating infrequently are less motivated to conserve heat (e.g., insulate homes) than households that pay monthly for electricity and gas. When an annual bill arrives it is large, totaling hundreds of dollars, which can provide a strong reminder to avoid waste.

H. Equity

Usage-Based Premiums are more actuarially accurate than current pricing, Mileage Rate Factor or PATP, and so increases horizontal equity (fairness). Per-Minute Premiums are likely to be somewhat more accurate than Per-Mile Premiums, but more research is needed to determine the magnitude of this impact, and it is likely to be modest. It has been promoted for more than a decade by the National Organization for Women as a way to eliminate existing insurance pricing inequities.[90]

Usage-Based Premiums can increase horizontal equity by reducing the need for cross-subsidies from low-risk to high-risk vehicles. Lower-risk motorists are currently overcharged to provide unlimited-mileage coverage that is affordable to higher-risk, lower-income drivers. There may be less opposition to charging cost-based per-mile fees since it allows higher-risk motorists to afford insurance by limiting their annual mileage. For example, some categories of motorists cost insurers more than $4,000 annually to insure, but this is generally considered excessive, and so is subsidized. A 20¢ per mile insurance fee may be more acceptable, and so the need for subsidies may be reduced.

In the future Usage-Based Premiums could allow insurance to be charged more directly to the driver, rather than the vehicle using a meter that tracks the mileage driven by different drivers. Thus, if a vehicle is used 90% by a low-risk driver (such as a parent) and only 10% by a higher-risk driver (such as a male teenager), premiums could be lower than if the proportion of vehicle use were reversed.

Usage-Based Premiums makes owning a low-mileage vehicle for basic transportation more affordable, and provides motorists with a new opportunity to save money, which particularly benefits lower-income households. Since average per-vehicle annual mileage

[90] Patrick Butler, Twiss Butler and Laurie Williams, 1988.

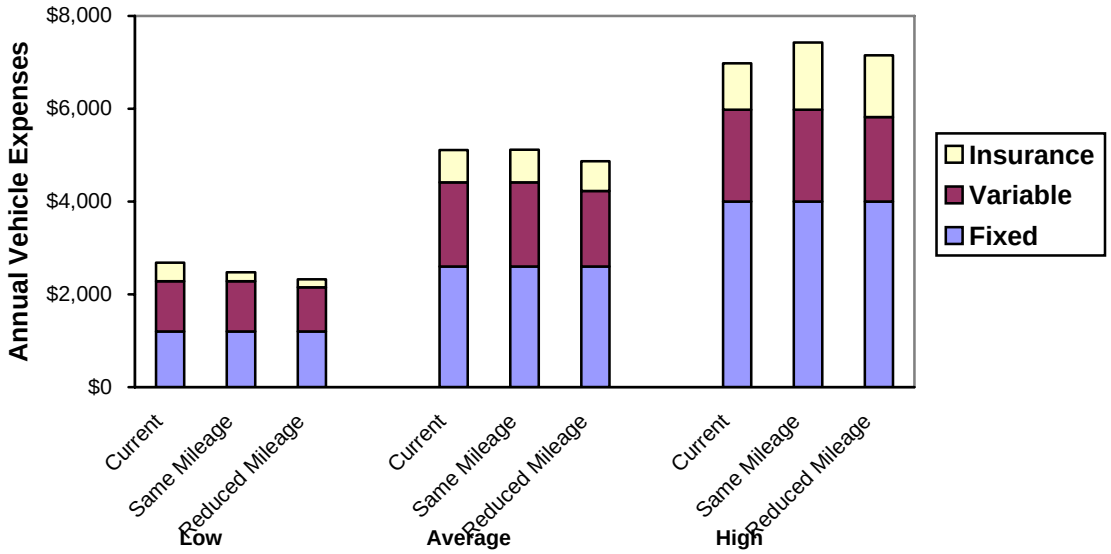
tends to increase with income, it tends to be progressive (increases vertical equity),[91] and can reduce the excessive insurance premiums in lower income residential areas.[92] Young, elderly, low income and urban residents are all likely to save on average. Per-Minute Premiums require a $30-40 annual equipment fee that reduce these affordability benefits.

Some people express concern about the geographic equity of this price strategy, since rural motorists tend to have higher mileage and lower crash rates than urban residents. Usage-Based Premiums can incorporate these factors because rates vary by territory. Rural drivers would pay relatively low per-mile fees. Only motorists who drive more than average in their class (i.e., more than other rural motorists) would pay more than they do now, even if that is significantly higher than overall average annual mileage.

I. Consumer Impacts

Consumers would bear odometer auditing or VUDAR costs. This is estimated to cost about $5.00 per auditor, or $5-7 per vehicle-year to account for vehicles that have multiple audits in a year. VUDAR is predicted to cost $20-30 per vehicle year.

Figure 23 **Current and Usage-Based Premiums Annual Costs Compared**



This compares costs for Low, Average and High mileage vehicles. "Current" refers to vehicles with fixed-price insurance. "Same Mileage" refers to vehicles with Usage-Based Premiums that do not reduce annual mileage. "Reduced Mileage" assumes a 10% reduction.

Figure 23 and Table 13 illustrate how this price option affects different motorists. A low-cost vehicle driven 6,000 miles annually saves $202 per year, a 7.5% reduction in total

[91] A model based on the 1995 NPTS suggests that a 10 percent increase in household income increases daily VMT by approximately 3.6 percent. Pickrell, Don and Paul Schimek, "Trends in Personal Motor Vehicle Ownership and Use: Evidence from the Nationwide Personal Transportation Survey," U.S. DOT Volpe Center, April 23, 1998. Appendix 1 of this report has additional data comparing mileage by income class.
[92] Patrick Butler, *Why The Standard Automobile Insurance Market Breaks Down In Low Income Zip Codes*, Report to the Texas House Committee on Insurance, July, 2000.

vehicle expenses. If vehicle travel is reduced 10%, as predicted, savings total $225 per year, an 8.4% reduction in vehicle expenses. An average vehicle driven 12,500 miles per year pays an additional $6 for odometer auditing, but $64 net insurance savings if vehicle travel declines 10% as expected. A vehicle driven 18,000 miles annually pays $446 more per year, a 6.4% increase in total vehicle costs, but this declines to $331 per year if annual vehicle-mileage decline by 10%. These cost changes (savings to lower-mileage motorists and higher costs to high-mileage motorists) increase by 20% if registration fees also become distance-based.

Table 13 **Usage-Based Premiums Consumer Cost Impacts**

Vehicle	If Vehicle Use is Unchanged	If Vehicle Use Declines 10%
Low (6,000 miles/yr)	-$202 (-7.5%)	-$225 (-8.4%)
Medium (12,500 miles/yr)	$6.00 (0.1)	-$64 (-1.3%)
High (18,000 miles/yr)	$446 (6.4%)	$331 (4.7%)

(Percentages in parenthesis indicate insurance cost changes relative to total vehicle costs.)

This example may give a false impression that overall loses are greater than overall gains because savings to the 6,000 miles/year motorist are smaller than cost increases to the 18,000 miles/year motorist. However, there are many more vehicles driven 6,000 miles annually as 18,000 miles annually, as indicated in Figure 1. Overall direct financial gains are equal to losses if there are no mileage reductions, and exceed losses if mileage declines (minus any additional transaction costs).

Savings result because distance-based pricing provides consumers with a new opportunity to save money. Vehicle owners would only forego travel that has less benefit than their incremental financial savings. This represents an increase in total consumer surplus and economic efficiency. Direct consumer surplus gains from Per-Mile Premiums are estimated to average $32 per vehicle, over 6 times greater than incremental consumer costs, indicating that average consumers would be directly better off with mandatory Per-Mile Premiums. Per-Minute Premiums has an additional $30 annual equipment cost borne by consumers. These equipment costs nearly equal consumer surplus benefits, indicating that an average consumer would perceive little or no direct benefit if Per-Minute Premiums were mandated. Of course, high-mileage motorists would not choose optional Usage-Base Premiums and so they would only be worse off to the degree that they lose current subsidies from low-mileage motorists.

Usage-Based Premiums can significantly increase insurance affordability, allowing some low-income motorists to own an automobile for basic mobility that they cannot otherwise afford, and middle-income motorists to afford specialized vehicles, such as an old truck, recreational vehicle, or collector's vehicle. This increased vehicle ownership provides additional consumer benefits (beyond the consumer benefits previously described).

Optional Usage-Based Premiums provides greater direct consumer benefits per participant, since it attracts motorists who save the most. However, much of these savings are economic transfers, resulting from a reduction in cross-subsidies from low- to high-mileage motorists. Eventually, higher-mileage motorists would need to pay more to offset their lost subsidies. Only the portion of consumer savings that result from mileage

reductions provide overall net benefits. Since motorists who drive less than average (i.e. under 12,500 miles annually) average about 7,000 miles per year as a group, total mileage reductions are relatively small. As a result, mandatory Usage-Based Premiums provide far greater total travel reductions and associated benefits than if it is optional.

J. Public Acceptability and Marketing

There would probably be strong public support for *optional* Usage-Based Premiums since it increases consumer choice. Support for *mandatory* Usage-Based Premiums is mixed. A 1997 focus group survey found 31.8% strongly supported and 19.7% supported it (52% total support), compared with 46% opposition.[93] Focus group facilitators reported that the concept has strong "ideological appeal." Individuals objected if they felt it would increase their costs, so higher mileage drivers expressed the most opposition while those who drive less tend to support it. Much of the debate appears to concern respondents' sense of their commute options. Those who have poor access to public transit (and therefore believe they must drive to work) felt that distance-based insurance would be an unfair burden. Support tended to decline with age.

An October 1998 poll found 40% of respondents supported distance-based insurance, while 55% oppose it.[94] A 1995 public opinion survey found that marginalizing fixed vehicle costs would be "highly acceptable" to the public if operated as a reward system and "totally unacceptable" if operated as a punitive system.[95] It had one of the highest positive rankings of all TDM strategies in the survey.

Many objections expressed in surveys reflect a poor understanding of the concept. One focus group participant asked, "What if you want to go out of town though?" and another, "What about the kilometres put on for a summer holiday?" Some participants suggest that it would force rural drivers to pay more than their share. These objections are true for Pay-at-the-Pump, but not for Per-Mile Premiums.

Diverse interest groups have expressed support for Usage-Based Premiums, including the National Motorists Association (a U.S. advocacy organization),[96] environmental organizations, transportation reform groups, the National Association of Independent Insurers in Oregon, regional governments, a chapter of the American Automobile Association, and the Oregon Consumer League. This suggests that public support could be high in other jurisdictions if comparable groups could be educated and mobilized.

K. Crashes

As described previously, a 10% reduction in vehicle travel reduces crashes by about 12%. In addition, Usage-Based Premiums give higher-risk drivers an extra incentive to reduce

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[93] Viewpoints Research, *Travel Demand Management: A Qualitative Analysis of Public Views*, Survey 30, BCTFA/GVRD, March 1996.
[94] Viewpoints Research, *BC Wild Communications Initiative: Province-Wide Polling Project*, BC Wild (Vancouver), October 1998.
[95] Viewpoints Research, "A Comprehensive Overview of TDM Public Opinion Research," Greater Vancouver Regional District (Burnaby), 1995.
[96] *NMA Position on Auto Insurance*, National Motorists Association (www.motorists.org/insurance), 1998.

their mileage; low risk motorists typically pay 2-4¢ per mile, while high risk drivers would pay four to six times as much, causing a greater reduction in their driving. Per-Mile Premiums is predicted to reduce crashes and claims about 14% per participating vehicle, and probably more as insurers are better able to identify motorists who have high per-mile crash rates, and as the need to subsidize high-risk drivers declines.

Per-Minute Premiums with variable rates that encourage motorists to shift from higher- to lower-risk time periods could further reduce crashes, although only experience will determine how much this reduces crashes. Some people have expressed concern that Per-Minute Premiums could encourage motorists to take additional risks in order to reduce their travel time. However, motorists already exhibit a strong tendency to minimize their travel time. Travel time research indicates that drivers typically have travel time values of 20¢ per minute or greater, several times higher than an average per-minute premium rate.

L. Energy Use and Emissions

Mandatory Usage-Based Premiums should reduce fuel consumption and virtually all vehicle emissions (including tail-pipe emissions, tire and road dust particulates, water pollution and noise) by about 10%, or 12% if registration fees also become distance-based. Optional Usage-Based Premiums would probably provide a somewhat greater reduction per participating vehicle, but a much smaller total reduction.

Pre-Minute Premiums could provide slightly greater emission reductions because it provides an extra incentive to avoid driving under congested conditions, and it encourages motorists to turn their engine off as soon as they stop. However, if motorists respond to this incentive by driving faster, fuel consumption and some types of emissions could increase compared with Per-Mile Premiums.

M. Economic Efficiency and Development

Per-Mile Premiums should increase economic efficiency by making the premiums better reflect costs, by giving motorists a new opportunity to save money, and by reducing various external costs of driving, including congestion, road and parking facility costs, crashes and pollution. Some businesses would pay more for vehicle insurance, but an equal number should pay less, since business vehicles have their own rate classes. As with private vehicles, businesses would have a new opportunity to save money and so could gain productivity, although such impacts, both positive and negative, would be small for most businesses relative to their total transportation costs (businesses typically spend $6,000-8,000 annually on a high-mileage vehicle, so a $200-400 change in insurance costs has modest financial impacts overall).

Per-Mile Premiums should increase economic development by reducing traffic congestion, road and parking facility costs, crash costs, and environmental damages. Reducing consumer expenditures on vehicles and fuel can increase regional economic development, since alternative consumer expenditures tend to provide more employment and business activity in the region, as discussed in Appendix 1.

Vehicle insurance broker commissions could decline 5-10%. The overall impact on brokers' income should be small, since most sell a variety of insurance. If vehicle

insurance commissions decline by 7% and vehicle insurance represents 30% of a broker's business, total commission would decline only 2%.

N. Summary of Advantages and Disadvantages

Advantages:

- *Choice.* Can be mandatory or optional.
- *Actuarial Accuracy.* Premiums more accurately reflect each vehicle's crash costs.
- *Affordability and consumer savings.* Significantly increases insurance affordability, due to low implementation costs and large potential consumer savings. Saves an average of about $60 per vehicle year, providing net consumer surplus benefits worth $30.
- *High penetration.* Per-mile pricing could be mandatory for all vehicles, and if optional it could attract a significant portion of total vehicles within a few years.
- *TDM benefits.* Large travel impacts result in large reductions in traffic congestion, facility costs and pollution.
- *Road safety.* Provides significant reductions in road crashes and claim costs.
- *Odometer audit benefits.* Odometer audit data could be used by used vehicle buyers to verify odometer readings, for transportation planning, as a way to make other vehicle fees, such as vehicle registrations or emission charges distance-based, and to charge different rates for different drivers of the same vehicle.

Disadvantages:

- *Implementation costs.* It would require establishing a new rate structure, an odometer auditing system, and changes to vehicle registration databases.
- *Uncertainty.* This system has not been used before. There is some uncertainty exactly how much mileage, crashes and insurance costs would decline.

Per-Minute Premiums have these additional advantages and disadvantages:

- Somewhat greater actuarial accuracy if rates vary by time period, although more research is needed to determine the magnitude of this benefit. This may increase traffic safety.
- Additional costs for VUDAR equipment, estimated at $30 per vehicle-year.

4. GPS-Based Pricing

GPS technology is used to price insurance according to when and where a vehicle is driven.

A. How It Works

With this price structure, insurance is priced based on when and where a vehicle is driven. Fees are higher for driving under higher-risk conditions. Other rating factors are incorporated, so a low-risk motorist pays less and a higher-risk motorist pays more for driving under the same travel conditions. Insurers send motorists a monthly or bi-monthly bill, similar to other utilities.

Global Positioning System (GPS) data are used to track vehicle travel. GPS uses a small electronic transponder to track an object's geographic location.[97] Transponders must be securely installed and wired into vehicles. Transponder installation currently costs $300-500 per vehicle, about half for equipment and half for labour. Equipment prices are declining, and within a few years many new cars will have factory-installed GPS systems. GPS-based services are marketed to motorists for communication, navigation and emergency response. For example, GM's OnStar service provides hands-free cellular telephone and Internet access, directional assistance, remote power door unlock, theft recovery, emergency roadside assistance and a panic button.[98]

GPS-Based Pricing can incorporate virtually any rating factor, including factors related to driver, vehicle, time and location of vehicle travel. As a result, it can be most actuarially accurate and provide the greatest safety benefits per participating vehicle. Because urban-peak driving tends to be relatively high risk, GPS-Based Pricing may also have a greater impact on traffic congestion and air pollution than other distance-based pricing strategies.

GPS-Based Pricing raises privacy concerns, since insurers would track each vehicle's location. These concerns can be addressed in several ways. Location-related data can be erased as soon as billing is calculated, and data could be protected by privacy laws.[99] Privacy issues could be a major political issue if GPS-Based Pricing were mandatory, but should not be a major issue if it is a consumer option. The use of in-vehicle instrumentation to calculate premiums may be subject to patient.[100] These factors may to limit market penetration for optional GPS-Based Pricing.

Other than the rate structure and location tracking system, most other features of insurance transactions would continue as they are now. There would be no other changes in the relationships between vehicle owners, brokers and insurance companies, and existing rating factors can be incorporated into GPS-based rates. High implementation costs and privacy concerns make GPS-Based Pricing unsuitable for mandatory implementation, so this analysis assumes it would be a consumer option.

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[97] "Location, Location, Location," *CIO Magazine* (www.cio.com) May 1, 2001.
[98] OnStar (www.onstar.com).
[99] For example, the Progressive Insurance Company's *Autograph* system records whether a vehicle was driven in an urban, suburban or rural area, but not its exact location.
[100] (http://l2.espacenet.com/espacenet/viewer?PN=EP0700009&CY=gb&LG=en&DB=EPD).

B. Price Structure

With GPS-Based Pricing, insurance coverage is priced by the minute, with rates that vary by time and location, as well as existing rating factors. For example, a motorist who now pays $600 a vehicle-year might pay 7¢ per minute under urban-peak conditions or at night, 5¢ under urban-off-peak conditions, and 3¢ per minute in rural areas. These rates would be lower for a motorist who currently pays $300 per vehicle-year, and higher for a motorist who currently pays $1,500 per vehicle-year. Motorists also pay a $10-20 fixed monthly fee for equipment, billing expenses and royalties.

C. Market Penetration

GPS-Based Pricing is likely to attract motorists who drive very low-mileage vehicles or want other GPS-based services, and who are not particularly concerned about loss of privacy. This is predicted to be 5-10% of current policies. This should increase somewhat over the next decade as more vehicles are manufactured with GPS transponders, but penetration would probably stay under 25% due to additional billing costs and privacy concerns.

A. History of This Concept

GPS vehicle tracking is a type of Intelligent Transportation System (ITS), which is a general term for telecommunications technologies applied to transportation system management. GPS is commonly used to track ships, trains, trucks and taxies. Several studies are examining the feasibility of using GPS technologies for road pricing.[101]

The Progressive Insurance Company has a comprehensive patient covering the use of virtually any form of in-vehicle tracking device or sensor other than a standard vehicle odometer for insurance pricing.[102]

In 1999 the Progressive insurance company established a GPS-based vehicle insurance pilot project in Texas, called *Autograph*, involving approximately 1,000 vehicles.[103] Participants are charged a US$15 per month fixed equipment fee. It is marketed as a cost effective option for vehicles that are driven less than average, vehicles that are seldom driven in higher-risk areas, and for motorists who value having OnStar services. Pilot project participants reportedly reduce their average mileage more than 13%, and save an average of 25%. The company plans to expand the program to other markets, and is receiving support from the U.S. Federal Highway Administration's Value Pricing Program. The Autograph pilot project has received considerable publicity.[104]

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[101] David Forkenbrock, *A New Approach to Assessing Road User Charges*, University of Iowa Public Policy Center (www.uiowa.edu), 2000.
[102] U.S. patent number 5,797,134 (www.delphion.com/details?&pn=US05797134__).
[103] *Autograph Coverage*. Progressive Mutual Insurance Company (www.progressive.com).
[104] "Paying for Car Insurance by the Mile," *New York Times*, 20 April 2000; Marcia Stepanek, "Q&A with Progressive's Peter Lewis," *BusinessWeek Online* (www.businessweek.com:/ebiz/0009/0912lewis.htm), 12 Sept. 2000; Ira Carnahan, "Insurance by The Minute," *Forbes*, 11 Dec. 2000, pp. 86-88; Lawrence Solomon, "Pay-Per-Minute Auto Insurance," *National Post* (www.nationalpost.com), 10 April 2001.

B. Actuarial Accuracy

GPS-Based Pricing can be the most actuarially accurate of any pricing strategy because it incorporates time and location as well as other rating factor. As actuaries gain experience with GPS-Based Pricing, actuarial accuracy should continually improve.

C. Implementation Requirements

Implementing GPS-Based Pricing would involve the following tasks:

6. Arrange licensing agreement with Progressive Insurance.
7. Develop a GPS-Based Pricing rate structure and regulations.
8. Develop a system to collect and process GPS data and generate bills. Insurers could develop this or contract with companies that already offer GPS-based vehicle services.
9. Arrange GPS transponder installation. This could involve contracts with GPS transponder suppliers for equipment, and vehicle electronics shops to perform installations.

Transition Costs

Implementing GPS-Based Pricing required developing a new rate plan and a new database system to process the GPS data and produce bills. These are one-time costs.

Transaction Costs

Incremental transaction costs include transponder purchase and installation (typically 1-2 hours of labour), data processing and billing, and patient licensing fees. Incremental costs are minimal for factory-installed systems, and for motorists who have GPS transponders installed for other reasons. Although transponder prices may decline somewhat in the future, labour costs probably will not. The Autograph program costs participants $15 per month. Progressive Insurance has not yet indicated what royalty fee they will charge. Although it is difficult to predict exactly how much these costs will eventually total, they would appear to average $150 or more per vehicle-year for the foreseeable future.

Financial Risk

As with Usage-Based Premiums, GPS-Based Pricing could pose financial risks if crashes decline less than vehicle travel. In multi-vehicle households, mileage and insurance costs could be shifted from GPS-Based Priced vehicles to those with fixed-mileage premiums.

D. Travel Impacts

GPS-Based Pricing saves motorists an average of about 5.6¢ per mile reduced, and more under urban-peak conditions. Travel reductions per participating vehicle are likely to be relatively high because GPS-Based Pricing should attract price-sensitive motorists, and billing would be more frequent (monthly or bi-monthly) than other distance-based pricing options. The Progressive Insurance Company's pilot project found travel reductions exceed 13% or more per participating vehicle.[105] On the other hand, its high costs limit penetration, and it would attract low-mileage vehicles, estimated to average 6,000 annual miles. A 15% mileage reduction by 10% of vehicles averaging 6,000 annual miles results in just a 0.8% reduction in overall vehicle travel.

[105] No pre-implementation baseline data was collected, but average mileage declined 13% after the first month, so actual reductions are probably greater.

E. Equity

Because GPS-Based Pricing is most actuarially accurate, it is most fair (horizontal equity). GPS-Based Pricing raises privacy concerns, which may be an equity issue if it were mandatory, but not if it is a consumer option.

Because GPS transponders are relatively expensive to install in older vehicles, GPS-Based Pricing will not be a cost effective option for most lower-income motorists for the foreseeable future, and so does little to make automobile insurance more affordable to lower-income motorists.

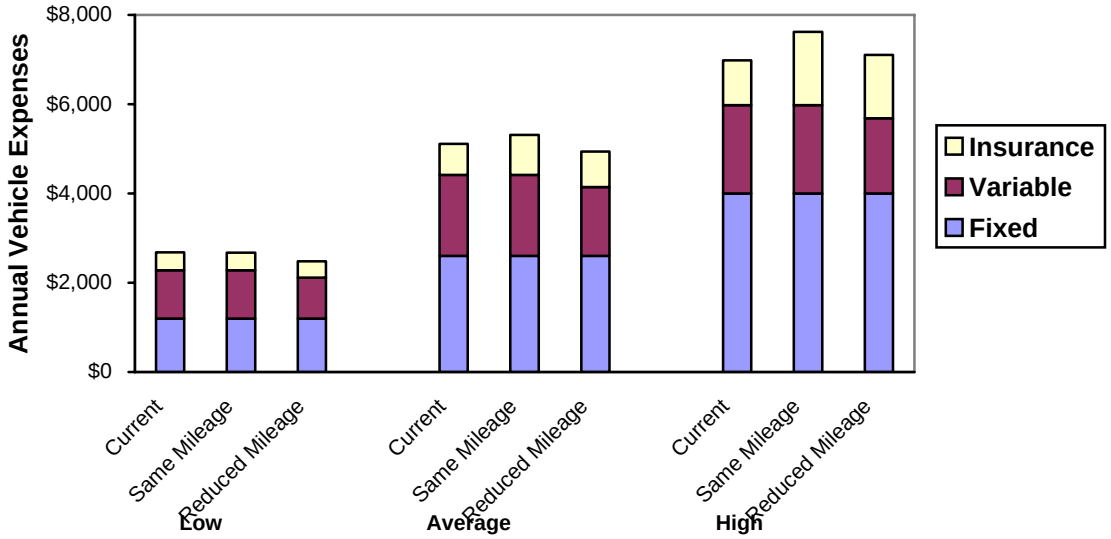
F. Consumer Impacts

GPS-Based Pricing allows more accurate pricing of risk and so maximizes motorists' opportunity to save money. Motorists could save money by reducing total driving, and by shifting driving to lower-risk locations and time.

Under most proposed systems consumers bear additional costs estimated to average $150 or more annually, although less for new vehicles with factory-installed transponders. For most motorists these overhead costs would more than offset the potential savings, making it an unattractive option. Only very low-mileage motorists are likely to find it attractive.

Figure 24 indicates the consumer financial impacts of GPS-Based Pricing.

Figure 24 **Current and GPS-Based Pricing Annual Costs Compared**



This illustrates how GPS-Based Pricing affects total vehicle costs "Current" refers to vehicles with fixed-price insurance. "Same Mileage" refers to vehicles with Usage-Based Premiums that do not reduce annual mileage. "Reduced Mileage" assumes a 10% reduction.

A low-mileage vehicle with basic insurance saves $58 annually, and $87 if annual mileage declines 15% as expected. An average vehicle that does not change its mileage bears $150 in additional costs, although this incremental cost may decline over time as

more vehicles are manufactured with GPS equipment. An average motorist that reduces mileage 15% pays $45 more in net insurance costs (savings minus equipment costs). A high-mileage vehicle driven 18,000 miles per year pays $590 more per year, or $374 more if vehicle travel declines 15% as expected. Of course, high-mileage motorists would not choose optional GPS-Based Pricing, and so they would only be worse off to the degree that they lose current subsidies from low-mileage motorists.

Table 14 **Change in Vehicle Costs from GPS-Based Pricing**

Vehicle Mileage Category	If Vehicle Use is Unchanged	If Vehicle Use Declines 15%
Low (6,000 miles/yr)	-$58 (-2.2%)	-$87 (-3.2%)
Medium (12,500 miles/yr)	$150 (2.9%)	$45 (0.9%)
High (18,000 miles/yr)	$590 (8.5%)	$374 (5.4%)

This table illustrates consumer cost impacts of GPS-Based Pricing. Numbers in parentheses indicate percentage change in total vehicle costs.

G. Public Acceptability and Marketing

As with Usage-Based Premiums, there appears to be support for *optional* GPS-Based Pricing, but there would probably be strong opposition to any sort of *mandatory* GPS-Based Pricing, due to privacy concerns and additional costs. Progressive Insurance has found consumer demand for optional GPS-Based Pricing.

H. Crashes

GPS-Based Pricing should provide the greatest crash reductions per participating vehicle of all distance-based pricing options, because it incorporates the most risk factors. It gives motorists an incentive to avoid higher-risk driving conditions. However, total crash reductions are relatively low due to its low penetration rate.

I. Energy Use and Emissions

GPS-Based Pricing reduces mileage by 15% per participating vehicle, and more under urban-peak conditions, which should result in greater than 15% reductions in fuel consumption and tail-pipe emissions. However, total reductions are small due to low penetration rates and low mileage for participating vehicles.

J. Economic Efficiency and Development

GPS-Based Pricing could increase economic efficiency by making the premiums better reflect costs, and by helping to achieve TDM objectives such as consumer savings, traffic congestion reduction, facility cost savings, reduced crash damages, environmental protection, and should support economic development, as described in Appendix 1. As with Per-Mile Premiums, reductions in premium payments would reduce broker commissions, but the effect is small, with total commissions declining less than 1%.

K. Summary of Advantages and Disadvantages

GPS-Based Pricing is most actuarially accurate. It provides an extra incentive to reduce higher risk driving and so can provide the greatest road safety benefits per participant. Actual advantages depend on how well actuaries are able to identify higher risk driving conditions, price elasticities, and safety benefits from reductions in such driving.

It costs $150 or more annually for most vehicles, and raises privacy concerns. The number of participating vehicles is likely to be small, resulting in modest total benefits. As more vehicles have factory-installed GPS transponders it may become more cost effective, but these will not be common for many years.

Advantages:

- *Actuarial accuracy.* Can provide the most accurate pricing.
- *Billing frequency.* Can bill motorists monthly or bi-monthly.
- *TDM benefits.* Can cause the greatest travel impacts per participating vehicle, and provides an extra incentive to reduce urban-peak driving.
- *GPS-related benefits.* GPS data could be used to provide a variety of services and benefits.

Disadvantages:

- *Equipment costs.* Equipment, billing and royalties add $150+ annually for most vehicles.
- *Privacy.* GPS data privacy is a concern to many motorists.
- *Low penetration.* Because of high costs and privacy concerns, penetration is expected to be low, and will consist of very low-mileage vehicles.
- *Minimal travel impacts and TDM benefits.* Because of low penetration rates, total travel impacts and TDM benefits are minimal. Total road safety, congestion reduction, facility cost savings, consumer savings and pollution reduction benefits are expected to be small.
- *No affordability.* Does little to increase insurance affordability, due to high equipment costs.

Summary of Distance-Based Pricing Options

Table 15 summarizes the distance-based insurance pricing options evaluated in this study.

Table 15 **Summary of Distance-Based Pricing Options**

Name	Description	Avg. Fee
MRF	*Mileage Rate Factor* is incorporated into premiums.	0.7¢/mile
PATP	*Pay-at-the-Pump* uses a fuel surcharge to provide basic insurance coverage for gasoline-powered vehicles.	1.4¢/mile
Per-Mile, Mand.	All vehicle insurance is priced by the mile or kilometer.	5.6¢/mile
Per-Mile Ins. & Reg.	All vehicle insurance and registration fees are priced by the mile or km.	6.8¢/mile
Per-Mile, Opt.	Motorists may choose between vehicle-year or vehicle-mile premiums.	5.6¢/mile
Per-Minute, Mand.	All vehicle insurance is priced by the vehicle-minute.	4.5¢/min.
Per-Minute, Opt.	Motorists may choose vehicle-year or vehicle-minute premiums.	4.5¢/min.
GPS-Based Pricing	Motorists may choose to purchase insurance based on when and where they drive using a GPS transponder installed in their vehicle.	5.6¢/mile

This table summarizes options evaluated in this study. (Mand.= Mandatory; Opt.= Optional).

Comparing Distance-Based Insurance Options

This section compares distance-based pricing options. See Appendix 1 for details about the evaluation criteria and analysis framework.

1. Actuarial Accuracy

Actuarial accuracy refers to how well premiums reflect a particular vehicle's crash and insurance costs. Actuarial accuracy makes premiums fair and gives motorists efficient price signals to reduce crash risks and claim costs.

Data described earlier in this report show a positive relationship between annual mileage and claims, indicating that distance-based insurance pricing can improve actuarial accuracy. Since other risk factors are also significant, actuarial accuracy requires that other rating factors be incorporated into pricing in addition to mileage.

Mileage Rate Factor only modestly increases actuarial accuracy. It is constrained by the weight that can be placed on self-reported estimates of future travel, since motorists cannot accurately predict how much they will drive, and tend to underestimate if given a financial incentive.

PATP is constrained by the difficulty of incorporating risk factors into a fuel surcharge. It tends to overcharge lower-risk motorists with high fuel consumption vehicles and undercharge higher-risk motorists with fuel-efficient vehicles. Rural residents as a group tend to be overcharged. Rating factors can be incorporated through fixed (not distance-related) surcharges on vehicle registration fees and drivers' licenses, which results in a trade-off between actuarial accuracy and distance-related pricing.

Usage-Based Premiums and GPS-Based Pricing can incorporate virtually any existing risk rating factor. Per-Mile Premiums significantly improve actuarial accuracy over current pricing. Per-Minute Premiums that vary by time may improve actuarial accuracy further, and GPS-Based Pricing that varies by time and location can improve accuracy the most, although only with experience can the magnitude of these gains be determined.

Actuarial Accuracy Rating Summary

	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Actuarial Accuracy	1	0	2.5	2.5	2.5	2.8	2.8	3

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

2. Implementation Costs

This refers to the incremental costs of implementing distance-based insurance pricing, including transition (temporary) and transaction (ongoing) costs.

Mileage Rate Factor has minimal implementation costs. It requires a revised rate plan and the addition of one field into the client database. Increased accuracy would require mileage data verification and enforcement systems that would add costs.

PATP has moderate *direct* implementation costs. It requires a revised rate plan and a system to collect drivers license and vehicle registration surcharges. Advocates claim that it reduces transaction costs by eliminating the need to purchase basic liability insurance, but motorists would still need to register vehicles, and most would purchase other types of coverage as they do now, so actual gains are likely to be small. PATP has two large *indirect* transaction costs. It reduces broker commissions by 30-45%, which may put some out of business or require insurers to raise commission rates. It is also expected to increase cross-border and illegal fuel purchases, which would reduce government revenue and business activity in a jurisdiction.

Usage-Based Premiums have low to moderate implementation costs. They require a new rate plan and an odometer auditing system. Odometer auditing is predicted to cost about $5 per vehicle year. It may require increased enforcement of odometer fraud. Per-Minute Premiums require installation of a VUDAR unit in each vehicle and annual data downloading, costing an estimated $30 per vehicle-year.

GPS-Based Pricing has the highest implementation costs. It requires a new rate plan, a GPS transponder installed in each vehicle, a billing system, and royalty payments. These are likely to total $150 or more annually for most vehicles for the foreseeable future, although this should decline somewhat over the next decade as more vehicles have factory equipped GPS-transponders. GPS-Based Pricing also raises privacy concerns.

Implementation Cost Rating Summary

	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Implementation Costs	-1	-3	-1	-1	-1	-2	-2	-3

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

3. Equity

Distance-based vehicle insurance can increase fairness (horizontal equity) by increasing actuarial accuracy. Currently, motorists who drive less than average tend to subsidize the insurance costs of motorists who drive more than average in their price class.

Distance-based pricing can also increase horizontal equity by redefining the concept of insurance affordability. Society currently considers it unacceptable to charge high-risk motorists premiums that represent their full insurance costs, and so overcharges lower-risk motorists. Distance-based pricing should make it more acceptable to charge high-risk motorists their full insurance costs, since individuals could achieve affordability by reducing their driving. For example, cost-based insurance pricing would be $3,000 or more for some rating classes, which is generally considered unacceptable, but the distance-based equivalent charge of 24¢ per mile may be more acceptable.

Since annual vehicle-mileage tend to increase with income, distance-based pricing tends to be economically progressive and makes insurance more affordable to lower income motorists (increases vertical equity). Although a few low-income motorists might pay more with distance-based pricing, their number is a small fraction of the lower-income people who would save money and find vehicle ownership affordable.

Mileage Rate Factor provides minimal equity benefits because only a small price shift is feasible with self-reported mileage data. It could create a new form of inequity: honest premium payers would overpay relative to motorists who understate their annual mileage.

PATP replaces one type of inequity (overcharging low mileage motorists) with another (overcharging low-risk drivers with fuel inefficient vehicles who do not evade the surcharge). PATP overcharges some groups, such as rural residents. In addition, motorists who pay the surcharge would overpay relative to motorists who receive coverage but purchase fuel in other jurisdictions or illegally.

Usage-Based Premiums significantly increases actuarial accuracy and provides significant savings to lower-income motorists, particularly if it is optional so motorists could choose the pricing option that provides the greatest savings. Per-Mile Premiums and Registration Fees provide the greatest increase in affordability. In theory, GPS-Based Pricing can achieve an even higher level of actuarial accuracy, but would probably do little to achieve vertical equity objectives because high transaction costs make it unsuitable for most lower-income motorists.

Equity Rating Summary

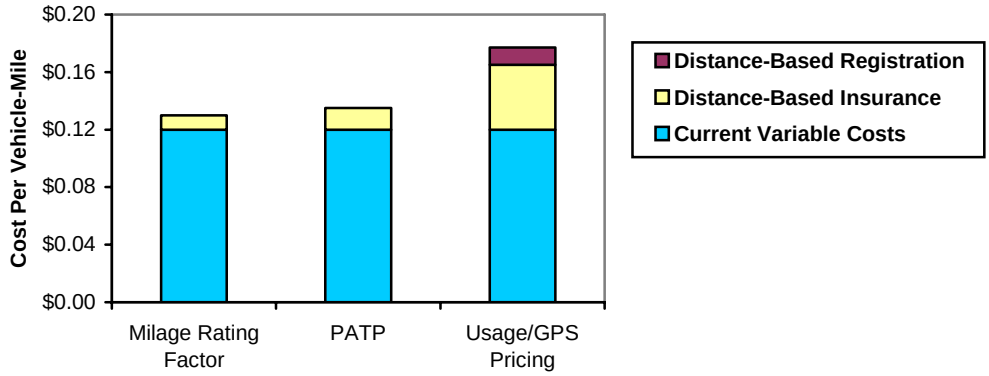
	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Fairness (Horizontal Equity)	1	0	2.5	2.5	2.5	2.8	2.8	3
Progressive (Vertical Equity)	1	-1	2.8	3	3	2	2	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

4. Consumer Impacts

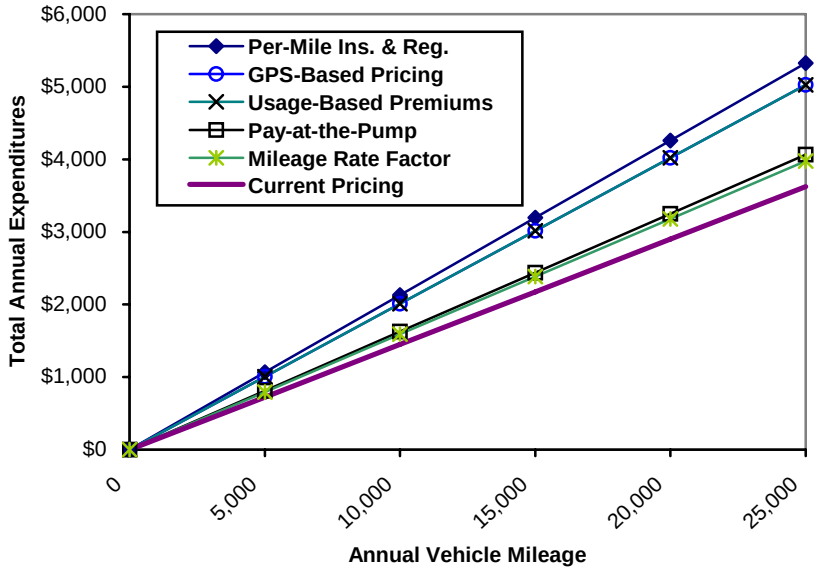
Distance-based insurance converts a fixed cost into a variable cost, giving motorists a new opportunity to save money. Average motorists who continue their current driving patterns pay the same as they do now, plus any implementation costs, while those who drive less can save money. Mileage reductions represent consumer benefits: low value vehicle travel that motorists forego in exchange for financial savings. In general, the greater the travel reduction, the greater the increase in consumer surplus (as discussed in Appendix 1). Figures 25 and 26 illustrate the increased variable vehicle costs from different distance-based insurance pricing options.[106]

Figure 25 **Distance-Based Insurance Impacts On Variable Vehicle Costs**



Distance-based insurance increases the variable costs offset by reductions in fixed costs.

Figure 26 **Vehicle Operating Costs Compared**



This figure compares how different options affect vehicle-operating costs.

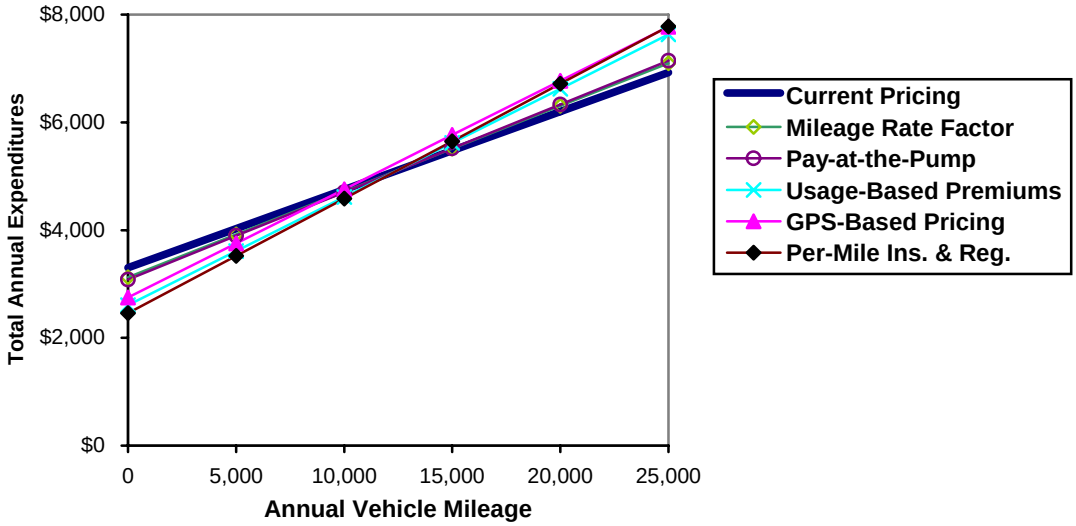
[106] This increases about 10% if premiums paid to private insurers also become distance-based.

Net consumer benefits consist of increased consumer surplus from reduced vehicle mileage minus any increased consumer costs, such as equipment fees. These extra costs are predicted to average $30 annually for Per-Minute Premiums and $150 for GPS-Based Pricing, which offset some or all of the consumer surplus benefits. As a result, Per-Minute Premiums and GPS-Based Pricing are only attractive to a minority of motorists (those with very low mileage), and so their overall consumer benefits are modest.

If distance-based pricing did not reduce vehicle mileage it would simply be an economic transfer, resulting in an equal amount of financial gains and losses. But as motorists reduce their mileage, total financial gains tend to exceed total losses. Data illustrated in Figure 4 indicate that only about 18% of motorists drive their vehicles more than 25,000 kms ($15,000 miles) annually, which suggests that only about one in five drivers would pay significantly increased (i.e., over 10% more) for insurance with distance-based premiums. Reduced mileage provides other vehicle savings, so even a high-mileage motorist would save in *total* vehicle costs if they reduce their mileage by 12% or more.

Usage-Based Premiums can significantly increase insurance affordability, allowing some low-income motorists to own an automobile for basic mobility that they cannot otherwise afford, and middle-income motorists to afford specialized vehicles, such as an old truck or recreational vehicle. The increased vehicle ownership provides additional consumer benefits, beyond those previously described. Consumers would also enjoy indirect benefits, including reductions in traffic congestion, crash risk, pollution, and road and parking facility costs, which would be greatest for higher-mileage drivers.

Figure 27 **Comparison of Total Costs By Annual Mileage**



This graph illustrates the effects different pricing options have on total vehicle costs.

Figure 27 shows how total vehicle costs vary with mileage travelled with different pricing strategies. Overall impacts are modest, since insurance is a small portion of total vehicle costs. Because older, inexpensive vehicles tend to be driven lower mileage and newer, expensive vehicles tend to be driven high mileage, distance-based insurance tends to provide greater savings to lower-mileage vehicles as a percentage of total costs than the percentage increase in total costs for higher mileage vehicles. For example, a $300

insurance cost reduction for a low-mile, low-cost vehicle driven by a lower-income motorist represent a 7% savings in annual vehicle costs, but a cost increase of the same size represents just 2.7% of total costs for a typical high-mileage vehicle.

Under some circumstances consumers seem to prefer fixed prices because they minimize transaction costs and are predictable. For example, some restaurants offer all-you-can-eat meals, and telecommunications companies offer fixed-rate telephone and Internet services. However, this preference appears to be weak, and fixed rate pricing is relatively uncommon in competitive markets. Grocery stores don't usually offer all-you-can-carry shopping, airlines don't usually sell unlimited-mileage tickets, and fuel is not sold by all-you-can-drive-per-vehicle-year. Many markets are shifting toward more marginal prices. Municipalities increasingly meter water consumptions, some electrical utilities are implementing time-based rates, and some toll roads now have variable rates. There is no evidence that consumers have a strong preference for fixed-priced insurance. Most motorists who would save money would probably choose optional distance-based insurance.

Virtually any form of *optional* pricing provides net benefits since motorists would only choose it if they considered themselves better off overall. Optional distance-based pricing results in greater direct consumer benefits per participating vehicle, although total social benefits are smaller due to reduced market penetration.

Mileage Rate Factor provides small financial impacts, and therefore minimal benefits. PATP provides moderate financial impacts, and therefore moderate benefits. Usage-Based Premiums and GPS-Based Pricing provide the greatest potential benefits, but Per-Minute Premiums and GPS-Based Pricing have high equipment costs that exceed the direct consumer surplus benefits for most motorists. As a result, they provide small overall benefits and do little to increase affordability. Optional GPS-Based Pricing could benefit some motorists who want other services that require GPS equipment in their vehicles.

Consumer Impacts Rating Summary

	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Consumer Impacts	1	2	3	3	3	2	2	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

5. Public Acceptability

Consumers value having choices, so there is likely to be strong support for optional distance-based pricing. Legislation supporting optional Usage-Based Insurance introduced in the 2001 Oregon legislature is endorsed by the National Association of Independent Insurers, regional governments, the Oregon/Idaho chapter of the American Automobile Association, the Oregon Consumer League, environmental organizations, citizen transportation reform groups and the Interfaith Global Warming Campaign.[107]

The limited available research (three public opinion surveys with ambiguous wording) indicates mixed public response to mandatory distance-based insurance.[108] Citizens generally support pricing that increases fairness and affordability and helps solve specific problems, but are skeptical of reforms that may increase their own costs or burden particular groups.

Mileage Rate Factor may be acceptable because it requires little change from current practices, but it provides little benefit, and citizens may be uncomfortable with pricing based on unverified data that rewards dishonest motorists. PATP appears to have the least support, due to equity concerns and a feeling that a fuel surcharge is a tax increase.

Usage-Based Premiums appears to have about equal levels support and opposition, with responses affected by the concept is described. Support tends to be more positive if described as a reward to consumers who reduce their mileage and use alternative modes, and more negative if presented as a surcharge on higher-mileage motorists. Support for Per-Minute Premiums is likely to be lower due to higher costs and privacy concerns. The Progressive Insurance GPS-Based Pricing pilot project indicates demand as a consumer option, although it raises privacy and equipment cost concerns, and so would probably face significant opposition if it were mandatory.

Most consumers have little knowledge of distance-based insurance. Many concerns about the concept are based on misconceptions. Public acceptance of distance-based insurance is likely to depend on policy makers' ability to demonstrate that its incremental costs (including motorist inconvenience) are modest, that it provides significant benefits, and that it is fair. If this can be done public acceptance would probably be high.

Public Acceptability Rating Summary

	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Public Acceptability	1	0	2	2	3	1	3	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

[107] Oregon HB 3871 www.leg.state.or.us/01reg/measures/hb3800.dir/hb3871.intro.html. Information from Christine Hagerbaumer of the Oregon Environmental Council (www.orcouncil.org), May 2001.
[108] Viewpoints Research, "A Comprehensive Overview of TDM Public Opinion Research," Greater Vancouver Regional District (Burnaby), 1995; Viewpoints Research, *Travel Demand Management: A Qualitative Analysis of Public Views*, BCTFA-GVRD, 1996; Viewpoints Research, *BC Wild Communications Initiative: Province-Wide Polling Project*, BC Wild (Vancouver), October 1998.

6. Travel Reduction Impacts

How much distance-based pricing reduces vehicle travel depends on market penetration, the magnitude of financial incentives, the average mileage of participating vehicles, and how it is implemented.

Mileage Rate Factor would apply to all policies by an insurer or in a jurisdiction, but its travel impacts are small. Pay-at-the-Pump applies to all gasoline-powered vehicles in a jurisdiction, but only converts 30-45% of total insurance premiums to distance-based pricing so its travel impacts are also modest.

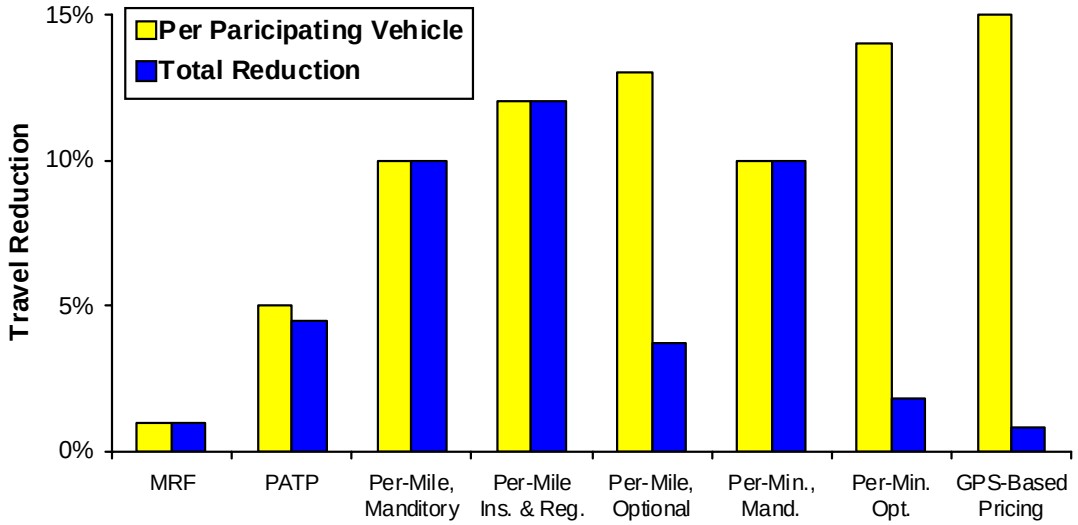
Usage-Based Premiums could be mandated for all vehicle insurance in a jurisdiction or be optional. Mandatory Per-Mile and Per-Minute Premiums would reduce total vehicle travel 8-10%, or 12% if registration fees are also distance-based. Optional odometer-based PAYD would probably attract 20-40% of total policies, representing a significant portion of motorists who expect to drive less than 80% of average annual mileage in their rate class, representing 10-20% of total mileage. Participation should increase over time as fixed-rate premiums increase, since they will lose the cross-subsidy from lower-annual-mileage motorists, eventually causing the market to shift to PAYD pricing, although this would probably take a decade or so. Optional Per-Minute Premiums would have a lower (perhaps half) penetration rate due to the additional equipment fee.

GPS-Based Pricing is likely to be optional due to cost and privacy concerns, and would attract only 2-5% of policies, consisting of very low mileage motorists not very concerned about privacy loss. This should increase over time as more vehicles are manufactured with GPS transponders, reducing equipment costs, and as fixed-rate premiums increase, but market penetration will probably stay low due to privacy concerns.

GPS-Based Pricing can have monthly or bi-monthly billing, which may cause greater travel reductions than Mileage Rate Factor and Usage-Based Premiums (although many motorists pay by the month, the rates are set annually, so there is typically several months lag between a reduction in mileage and financial savings). More frequent mileage data collection is possible using new technologies, but would increase costs.

Optional PAYD participation rates could be increased if motorists or insurance companies were offered suitable incentives.

Figure 28 Distance-Based Insurance Impacts On Vehicle Travel



This figure compares the travel impacts of each option. Travel reductions per participating vehicle depend on the size of the per-mile fee. Strategies with high implementation costs have low penetration rates and are most attractive to low annual mileage vehicles, and so cause relatively small reductions in total vehicle travel.

Because optional distance-based pricing attracts lower-mileage motorists, total mileage reductions are relatively small. Penetration of optional distance-based pricing could increase with suitable incentives (such as subsidies), which might be provided due to social benefits. Marketing might increase travel reduction. Figure 28 and Table 16 summarizes predicted travel impacts.

Table 16 **Travel Reduction Impacts**

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Market penetration	100%	90%	100%	100%	50%	100%	25%	10%
Price increase per mile	0.7¢	1.4¢	5.6¢	6.8¢	5.6¢	5.6¢	5.6¢	5.6¢
Red. per participating veh.	1.0%	5.0%	10%	12%	13%	10%	14%	15%
Total VMT reduction	1.0%	4.5%	10%	12%	3.7%	10%	1.8%	0.8%

Travel Impact Rating Summary

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Travel Impacts	1	2	2.8	3	2	2.8	2	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

7. Road Safety

As described earlier in this report, a 1% reduction in total vehicle mileage typically reduces total vehicle crashes by about 1.2%, including crash reductions to the vehicle that reduces its mileage and to other road users. PATP may provide somewhat smaller reductions in crash damages if it causes a shift to vehicles with less crash protection, although the magnitude of this impact is uncertain.

Usage-Based Premiums gives higher risk motorists extra incentive to reduce their driving. GPS-Based Pricing also gives motorists an incentive to avoid higher-risk driving conditions. To the degree that insurers can identify higher risk vehicles and travel conditions and encourage these mileage reductions, per-mile crash rates should decline even more. As a result, each 1% reduction in VMT should reduce crashes by 1.4-1.6%.

The table below compares estimated crash reduction impacts and estimated monetized benefits.

Table 17 **Estimate of Road Safety Benefits**

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Total VMT reduction	1.0%	4.5%	10%	12%	3.7%	10%	1.8%	0.8%
Crash red. per VMT red.	1.2	1.1	1.4	1.4	1.4	1.5	1.5	1.6
Total crash reduction	1.2%	5.0%	14%	16.8%	5.2%	15%	2.6%	1.2%

This table summarizes the safety benefits of distance-based insurance. Total savings include additional benefits to society of reduced crashes besides insurance savings.

Road Safety Rating Summary

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Road Safety	1	2	2.8	3	2	2.8	2	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

8. Congestion and Facility Cost Savings

Traffic congestion reductions and roadway facility cost savings are somewhat difficult to predict because it is uncertain what portion of travel reductions would occur under congested conditions (peak-period travel tends to be less price sensitive than off-peak travel). Traffic congestion is a non-linear function; even a small reduction in demand can provide a large reduction in congestion delays. Although predicting such impacts requires modeling beyond the scope of this report, studies described in Appendix 1 have estimated average external costs imposed by vehicle use.

Most distance-based pricing strategies are assumed to provide congestion reductions in proportion to their mileage reductions. Per-Minute Premiums and GPS-Based Pricing provide somewhat greater congestion reductions benefits per unit of reduced mileage because they have higher fees under urban-peak travel conditions. However, as a consumer option their total VMT reductions are small and they would not be chosen by motorists who drive frequently under urban-peak conditions, and so would probably have only modest congestion reduction benefits.

Table 18 summarizes the value of predicted benefits.

Table 18 **Congestion Reduction and Facility Savings Benefits**

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Total VMT reduction	1%	4.5%	10%	12%	3.7%	10%	1.8%	0.8%
Peak-period reduction	1%	4.5%	10%	12%	3.7%	11%	1.9%	1.0%

This table compares estimated benefits of reduced traffic congestion, and road and parking facility cost savings.

Congestion Reduction Rating Summary

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Congestion Red.	1	2	2.8	3	2	2.8	1.5	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

9. Energy and Emission

Mileage Rate Factor and Per-Mile Premiums reduce fuel consumption and emissions in proportion to vehicle travel reductions.

PATP would reduce fuel consumption and fuel related emissions by a significantly larger amount. For this analysis we assume that PATP fuel consumption reductions are 3 times travel reductions, meaning that 1/3 of total fuel savings comes from travel reductions and 2/3 come from increased vehicle fuel efficiency.

Per-Minute Premiums and GPS-Based Pricing could provide a somewhat greater reduction in fuel consumption and emissions because a greater portion of driving reductions are likely to occur under urban-peak travel conditions, although the extent of this impact is difficult to predict.

The results are summarized in the table below.

Table 19 **Estimated Fuel Savings and Emission Reduction Benefits**

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Total VMT Reduction	1%	4.5%	10%	12%	3.7%	10%	1.8%	0.8%
Total energy savings	1%	13.5%	10%	12%	3.7%	11%	1.9%	1.0%

Energy Conservation and Pollution Reduction Rating Summary

	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Energy/Emissions	1	3	2.8	3	2	2.8	1.5	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

10. Economic Efficiency and Development

Appendix 1 discusses ways in which distance-based pricing can affect economic efficiency and development. Economic efficiency increases with actuarial accuracy and reductions in traffic congestion, road and parking facility costs, crashes and environmental degradation. Shifting expenditures from petroleum to other consumer goods tends to increase employment and business activity in the region. This indicates that distance-based insurance can increase economic development.

Mileage Rate Factor would provide small but positive economic benefits. PATP could provide moderate benefits from reduced traffic externalities, but it could have significant economic costs by increasing cross-border and illegal fuel sales, and it may discourage some tourism, resulting in lost government revenue and business activity in a jurisdiction.

Usage-Based Premiums and GPS-Based Pricing could provide significant economic efficiency, productivity and development benefits, because they are most actuarially accurate and provide the greatest incentive to reduce vehicle travel. These benefits increase if registration fees are also distance-based.

GPS-Based Pricing implementation is constrained by equipment costs, and so provides minimal total benefits for the foreseeable future. An odometer auditing or GPS system could provide a number of additional benefits including vehicle history data that should reduce odometer fraud, vehicle travel data for use in transport planning, the ability to charge different insurance rates for different drivers using the same vehicle, and the opportunity to make other vehicle charges distance-based.

Economic Efficiency and Development Rating Summary

	MRF	**PATP**	**Per-Mile** Mand.	**Per-Mile** Ins. & Reg.	**Per-Mile** Opt.	**Per-Min.** Mand.	**Per-Min.** Opt.	**GPS-Based**
Energy/Emissions	1	-2	2.8	3	2	2.8	1.5	1

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

Summary

Table 20 summarizes ratings according to the twelve evaluation criteria.[109] Mileage Rate Factor ranks highest only for implementation costs. PATP ranks high in energy conservation/emission reductions, and medium in several categories since it causes moderate vehicle travel reductions. Mandatory Per-Mile Premiums ranks high in most categories because it has modest implementation costs and causes the largest vehicle travel reduction. Benefits increase further if registration fees are also mileage-based. Mandatory Per-Minute Premiums rates slightly lower in some categories due to high implementation costs. Optional Per-Mile and Per-Minute Premiums have lower ratings in most benefit categories because of their smaller travel reductions. GPS-Based Pricing is most actuarially accurate but has high costs and faces privacy concerns that limit its penetration, particularly for older, inexpensive vehicles, so it does little to increase affordability. Its small mileage reduction provides minimal overall benefits and a low overall ranking.

Table 20 **Impact Rating Summary**

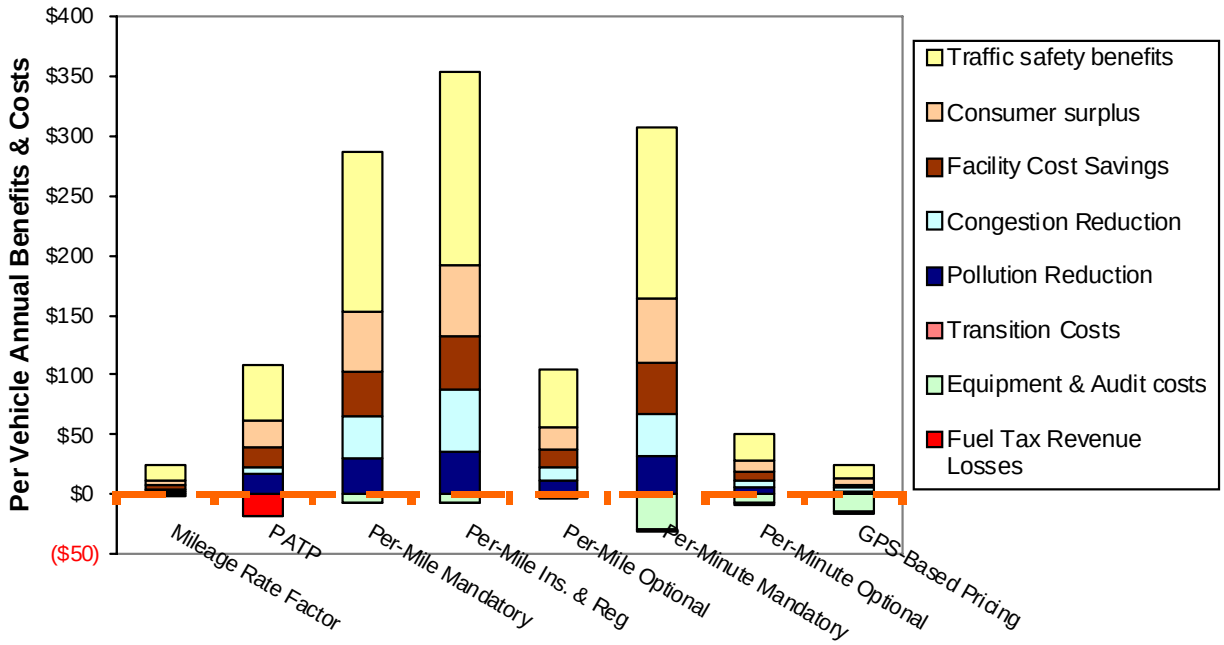
	MRF	PATP	Per-Mile Mand.	Per-Mile Ins. & Reg.	Per-Mile Opt.	Per-Min. Mand.	Per-Min. Opt.	GPS-Based
Actuarial Accuracy	1	0	2.5	2.5	2.5	2.8	2.8	3
Implementation Costs	-1	-3	-1.5	-1.5	-1	-2	-2	-3
Fairness	1	0	2.5	2.5	2.5	2.8	2.8	3
Progressive	1	-1	2.8	3	3	2	2	1
Consumer Impacts	1	2	3	3	3	2	2	1
Public Acceptability	1	0	2	2	3	1	3	1
Travel Impacts	1	2	2.8	3	2	2.8	2	1
Road Safety	1	2	2.8	3	2	2.8	2	1
Congestion Reduction	1	2	2.8	3	2	2.8	1.5	1
Energy/Emissions	1	3	2.8	3	2	2.8	1.5	1
Economic Development	1	-2	2.8	3	2	2.8	1.5	1
Totals	***9***	***5***	***25.3***	***26.5***	***23***	***22.6***	***19.1***	***11***

Rating from -3 (high cost/undesirable) to 3 (highly beneficial/desirable).

Figure 29 and Table 21 compare estimated monetized benefits and costs of the seven options (Appendix 1 discusses how these values were quantified). The analysis indicates that all options provide net benefits. Mileage Rate Factor has minimal implementation costs but causes minimal travel reductions and so provides minimal benefits. PATP provides moderate benefits but its costs are high due to revenue losses from cross-border and illegal fuel purchases. Mandatory Per-Minute Premiums provide the greatest total benefits due to large travel reductions and an extra incentive to avoid peak-period travel, but has relatively high implementation costs. Per-Mile Premiums provide almost the same benefits with minimal implementation costs, and so has the greatest net benefits. Optional distance-based pricing provides smaller benefits due to limited participation, causing relatively small mileage reductions and net benefits. GPS-Based Pricing has the lowest participation rate and the highest per-vehicle implementation costs, and so has the lowest net benefits.

[109] For comparable analysis see Ian W. H. Parry, "Comparing Alternative Policies to Reduce Traffic Accidents," *Journal of Urban Economics*, Vol. 54, No. 2, www.elsevier.com, Sept. 2004, pp. 346-368.

Figure 29 **Summary of Total Benefits and Costs**



This figure illustrates monetized benefits (above the dashed orange line) and costs (below the line).

Both mandatory and optional Per-Mile Premiums have Benefit/Cost ratios that exceed 25. Each of the five monetized benefits individually exceed their incremental costs. Even if costs were far greater than predicted (for example, if odometer auditing cost $20-40 annually per vehicle, rather than the $5-7 that is predicted), each of the five benefits would individually provide net benefits. This indicates that even under a worst-case scenario with much greater costs and lower benefits than this study predicts, implementation of Per-Mile Premiums would still be a cost effective public policy. These benefits increase further if registration fees are also mileage-based.

Table 21 **Benefit/Cost Analysis** (Annualized Values Per Vehicle)

	MRF	PATP	Per-Mile Mandatory	Per-Mile Ins. & Reg.	Per-Mile Optional	Per-Min. Mandatory	Per-Min. Optional	GPS-Based
Road safety	$12.00	$47.25	$135.00	$162.00	$49.14	$142.50	$23.94	$10.80
Congestion reduction	$5.00	$22.50	$50.00	$60.00	$18.20	$55.00	$9.24	$4.68
Facility cost savings	$3.75	$16.88	$37.50	$45.00	$13.65	$41.25	$6.93	$3.51
Pollution reduction	$3.00	$18.00	$30.00	$36.00	$10.92	$33.00	$5.54	$2.81
Consumer surplus	$0.66	$4.43	$35.00	$51.00	$12.74	$35.00	$5.88	$2.52
Total Benefits	*$24*	*$109*	*$288*	*$354*	*$105*	*$307*	*$52*	*$24*
Transition costs	-$0.38	-$0.35	-$0.65	-$0.65	-$1.05	-$0.85	-$1.25	-$1.50
Equipment/audit costs	-$0.60	$0.00	-$6.00	-$6.00	-$3.00	-$30.00	-$7.50	-$15.00
Fuel tax revenue losses	$0.00	-$17.19	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Costs	*-$0.98*	*-$17.54*	*-$6.65*	*-$6.65*	*-$4.05*	*-$30.85*	*-$8.75*	*-$16.50*
Net Benefits	***$23.43***	***$91.52***	***$280.85***	***$347.35***	***$100.60***	***$275.90***	***$42.78***	***$7.82***
B/C Ratio	***25***	***6.2***	***43***	***53***	***26***	***9.9***	***5.9***	***1.5***

Barriers, Costs and Concerns

This section discusses barriers, costs and concerns related to distance-based insurance pricing. Appendix 5 includes additional discussion of these concerns.

1. Transition and Transaction Costs

Implementing distance-based pricing requires developing new administrative procedures, a new rate structure, and modifying computer programs. These costs are significant, totaling hundreds of thousands of dollars for a typical insurance company, but small compared with potential savings and benefits. For example, assuming that transition costs total $2 million, this represents an annualized cost of about $200,000. If 20,000 clients choose optional distance-based pricing, these transition costs would average about $10 annually per participating vehicle, compared with annual insurance cost savings predicted to average $50-100 annually per participating vehicle. Transition costs can be minimized by implementing distance-based pricing in conjunction with other planned changes in rates and procedures.

2. Transaction Costs

Most distance-based pricing systems increase transaction costs due to increased data collection and processing requirements. Incremental costs per participating vehicle are expected to range from less than $10 per year for Mileage Rate Factor and Per-Mile Premiums, to more than $150 per year for GPS-Based Pricing. Per-Minute Pricing has annual transaction costs estimated to average about $40 per year. Transaction costs for Pay-At-the-Pump are likely to be high if cross-border revenue leakages are included. These costs may be major constraints on implementation of GPS-Based Pricing and PATP.

3. Financial Risks

Distance-based pricing introduces several potential financial risks described below.

Premium Uncertainty

It makes premium payments and revenues less predictable. Motorists and insurers would not be able to calculate total premiums until the end of the insurance term. This would introduce additional financial uncertainty to insurance companies. For example, if motorists reduce their driving more than expected, total annual premium revenues would be smaller than expected. This uncertainty is likely to decline over time as insurance companies gain experience with distance-based pricing.

Insufficient Insurance Cost Savings

It is possible that mileage foregone will be lower than average risk, so premium revenue would decline more than claim costs. For example, participating vehicles could reduce average vehicle mileage and therefore premium payments, by 10%, but crashes and claims only decline by 5%, making insurance companies financially worse off.

However, there is no evidence that this would actually occur. Available evidence indicates that mileage reductions provide a proportionately *larger* reduction in total crash costs, including the reduction in crash risk to other road users.

Adverse Selection

Optional distance-based pricing could attract motorists with relatively high per-mile claim costs within their price group. For example, a rate class might have claim costs that average 6¢ per mile overall, but the subgroup that would choose optional per-mile pricing averages 8¢ per mile, so revenue reductions would be greater than claim cost savings. This concern should disappear over time as actuaries gain experience with distance-based pricing, and are better able to determine accurate per-mile costs for different vehicles.

Risk Shifting

With optional distance-based pricing, motorists in multi-vehicle households could shift driving and claim costs to vehicles with fixed-rate premiums. Insurers may need to require all vehicles in a household have distance-based pricing, or impose a surcharge on fixed-rate premiums if other vehicles in a household have distance-based pricing.

Reduced Gross Revenue

If distance-based pricing is effective at reducing crashes and insurance costs as predicted, it will reduce gross premium revenue. Although revenue reductions would be offset by reduced claim costs, this reduces investment income, which could reduce insurance company profits (investment income is currently a major source of profits for insurance companies). This may help explain why the insurance industry has not embraced distance-based pricing. With most likely scenarios, distance-based pricing would not actually reduce total revenues, rather it would reduce revenue growth rates.

Odometer Fraud

Some motorists may attempt odometer fraud to steal insurance. Detailed analysis (see Appendix 4) indicates that this problem is unlikely to be significant. Fraud rates should be comparable to other common consumer transactions, and lower than with current pricing (insurers now have no system to verify insurance rating factors, such as commute distance). Regular odometer auditing should discourage and identify most tampering, odometers are increasingly tamper resistant, and the financial incentive for fraud is relatively low. The financial exposure to insurers would be minimal since odometer fraud can often be identified during accident investigations, which would void coverage.

Increased Premiums for Some Motorists

Mandatory distance-based pricing would increase premiums for higher-mileage motorists. A motorist who drives 18,000 annual miles in a price category that averages 12,000 annual miles would pay 50% more than they do now. Since high-mileage motorists tend to have low per-mile crash rates, per-mile premiums calculated by dividing current premiums by average annual mileage may overcharge such drivers. This concern will disappear over time as actuaries gain experience with distance-based pricing and are better able to determine per-mile costs for different risk classes.

With optional distance-based pricing, motorists who driver more than average would generally not choose it and so would not pay higher premiums directly. However, over time all fixed rate premiums may increase as lower annual mileage, lower annual risk motorists shift to distance-based pricing. The annual mileage level at which distance-based pricing is considered financially attractive to motorists will increase. Eventually, most motorists would probably shift to distance-based pricing.

Only the approximately 20% of motorists who drive more than 15,000 annual miles would experience a significant (greater than 10%) increase in insurance costs with distance-based pricing. These increases are small as a portion of total vehicle costs, since high annual mileage vehicles have high annual costs. For example, a vehicle driven 18,000 annual miles with current insurance premiums of $1,000 would pay $500 more under mandatory distance-based pricing, but such a vehicle typically costs about $8,000 per year to operate, representing an increase of just 6.2% in total vehicle costs.

There is no evidence that higher insurance costs for high annual mileage vehicles would be a significant financial burden. Motorists who drive more than 18,000 miles annually tend to have relatively high incomes, or drive for business, with reimbursed vehicle expenses. Standard vehicle use reimbursement and tax deduction factors compensate insurance costs on a per-mile basis, equivalent to distance-based pricing. Because of their high level of exposure to traffic, high annual mileage motorists would tend to benefit more than average from reductions in traffic and parking congestion, crash risk and pollution emissions from distance-based insurance pricing.

Reduced Broker Commissions

Distance-based pricing is likely to reduce broker commissions. This could be significant with Pay-at-the-Pump, which reduces gross vehicle insurance sales by half, but other distance-based pricing strategies would have much smaller impacts. Optional distance-based pricing is likely to reduce total sales by 2-4%, and mandatory distance-based pricing could reduce total sales by as much as 10%. Impacts on brokers' total income should be small, since most sell a variety of insurance. If vehicle insurance commissions decline by 7% and vehicle insurance represents 30% of a broker's business, total commission would decline only 2%. With most likely scenarios, distance-based pricing would only reduce commission growth rates rather than actually reducing revenue.

Mixed Political Support

There is likely to be strong popular support for *optional* distance-based insurance, since most consumers value increased choices, but mandatory distance-based insurance pricing has mixed popular support, although results depend significantly on how questions are worded. Surveys and focus groups indicate that about the same number of people support and oppose the concept, but opponents tend to have stronger feelings.

However, focus group interviews indicate that at least some opposition to distance-based pricing reflects concerns about specific strategies (particularly Pay-at-the-Pump), or misunderstandings about the concept and its impacts. Opposition to distance-based pricing can be addressed through education, and by starting with small pilot projects that implement distance-based pricing as a consumer option.

Innovation

Some insurance professionals argue that distance-based pricing is risky because it is an untried concept. But insurance rates for fleets and commercial vehicles are often based on mileage, and Progressive Insurance now offers GPS-based pricing. Prices for most goods are based on some measure of consumption. For example, electricity, fuel and food are not usually sold with a fixed price that allows unlimited use. Prices for many goods are shifting toward more marginal-cost pricing, such as metered residential water.

Conclusions

This study investigates the feasibility, benefits and costs of implementing distance-based vehicle insurance. It is based on a literature review, analysis of data on the relationship between vehicle mileage and insurance claims, information on a recent distance-based pricing pilot project, economic analysis of different distance-based pricing options, and evaluation of various concerns that have been raised about distance-based pricing.

A unique database shows that annual claims tend to increase with annual vehicle travel. Annual mileage is one of several factors that have a significant impact on annual crash rates. It would not be actuarially accurate to use mileage *instead* of other rating factors, for example, to charge all motorists the same per-mile insurance fee, but actuarial accuracy improves significantly if annual mileage is incorporated *in addition* to existing rate factors. Any other price structure overcharges low-mileage motorists and undercharges high-mileage motorists within each price class.

Distance-based insurance reflects the principle that prices should be based on costs. It does not simply shift costs from one group to another. It gives consumers a new way to save money by returning to individual motorists the insurance cost savings that result when they drive less. This lets motorists limit their insurance costs by limiting consumption, as with most other consumer goods. Motorists who continue their current mileage would be no worse off on average then they are now (excepting additional transaction costs), while those who reduce their mileage could save money. These result in net savings to motorists and net benefits to society.

Distance-based insurance is technically and economically feasible. One private insurer has successfully implemented GPS-Based Pricing, although it is the most technically difficult and expensive distance-based pricing option.

Distance-based pricing can help achieve several public policy goals, including actuarial accuracy, equity, affordability, road safety, consumer savings and choice, reduced traffic congestion, road and parking facility cost savings, and environmental protection. It can reduce the need for cross-subsidies currently required to provide “affordable” unlimited-mileage coverage to high-risk drivers.

Distance-based insurance is an outstanding traffic safety strategy. Because most crashes involve multiple vehicles, reduced vehicle mileage can cause a proportionally greater reduction in crash costs and insurance claims. Some types of distance-based insurance give higher-risk drivers an extra incentive to reduce mileage, and some give motorists an extra incentive to avoid higher risk travel conditions. As a result, each 1.0% reduction in total mileage caused by distance-based insurance can reduce total crash costs by 1.4% to 2.0%. Distance-based insurance could reduce total crashes by 15% or more.

Distance-based pricing can provide substantial benefits to lower-income motorists. Since annual vehicle mileage tends to increase with income, fixed-price insurance tends to cause lower-income motorists to subsidize the insurance costs of higher-income motorists within their rate class. Distance-based insurance pricing provides overall savings to lower-income motorists, and would allow some low-income households to insure a vehicle used for basic mobility that they currently cannot afford.

This study evaluated several distance-based pricing options:

1. *Mileage Rate Factor* (MRF) incorporates an annual mileage rate factor into the existing rate system. It is the easiest option to implement, but is constrained by the weight that can be placed on self-reported mileage estimates. Its travel impacts and benefits are small.

2. *Pay-at-the-Pump* (PATP) funds basic insurance coverage through a surcharge on fuel sales. It is not actuarially accurate because payments are based on vehicle fuel consumption, not risk factors. Less than half of insurance payments would be distance-based, and cross-border and illegal fuel purchases could be major problems. It causes a relatively large reduction in fuel consumption but modest reductions in vehicle travel, providing modest overall benefits. There would probably be little administrative cost savings because motorists would still need to pay registration fees and purchase optional coverage as they do now.

3. *Per-Mile Premiums* changes the unit of exposure from the vehicle-year to the vehicle-mile, incorporating all existing rating factors. It requires odometer audits to provide accurate mileage data, predicted to cost an average of $6 per vehicle year. It could be mandatory or a consumer option. It significantly improves actuarial accuracy and provides significant consumer savings, particularly to lower income households. Because it causes large reductions in vehicle travel it provides large benefits. As a consumer option it is predicted to attract 25-50% of motorists within a few years, and this should increase over time.

4. *Per-Minute Premiums* uses a small electronic meter to record when an engine operates, predicted to cost $30 per year. This allows rates to vary by time of day. Because it can give motorists an extra incentive to reduce their peak-period travel it can provide even greater benefits than Per-Mile Premiums, but the additional equipment costs reduce the net benefits. As a consumer option it is predicted to attract 12-25% of motorists within a few years.

5. *GPS-Based Pricing* uses GPS (Global Positioning System) technology to track vehicle travel, allowing insurance prices to reflect when and where a vehicle is driven in addition to existing rating factors. It is predicted to cost $150 or more per vehicle-year and raises privacy concerns. Installation costs may decline somewhat in the future as more vehicles have factory-equipped GPS transponders. It is most actuarial accurate and can cause the greatest crash reduction per participating vehicle. However, its high equipment costs offset the direct benefits for most consumers. As a consumer option it is predicted to attract 10% or less of total motorists, so total benefits would be modest for the foreseeable future.

Table 22 summarizes the implementation costs and effectiveness at achieving various objectives for the seven distance-based pricing options considered in this study.

Table 22 **Summary of Distance-Based Pricing Options**

	Implementation Costs	Effectiveness
Mileage Rate Factor	Low	Low
Pay-At-The-Pump	High	Medium
Per-Mile Premiums, Mandatory	Low	High
Per-Mile Premiums, Optional	Low	Medium
Per-Minute Premiums, Mandatory	Medium	High
Per-Minute Premiums, Optional	Medium	Medium
GPS-Based Pricing	High	Low

This table summarizes overall implementation costs and effectiveness at achieving objectives.

This analysis indicates that Mandatory Per-Mile Premiums provide the greatest net benefits, due to relatively low costs and high effectiveness at achieving objectives. It provides direct financial savings and net benefits to most motorists, and less than 1 in five would perceive significantly higher insurance costs. These benefits increase further if vehicle registration fees are also mileage-based. Optional distance-based pricing results in greater direct consumer benefits per participating vehicle, but smaller total benefits due to low market penetration and the low average mileage of motorists who would choose it. However, market penetration is predicted to increase over time as it becomes more financially attractive compared with fixed-rate premiums.

Because Per-Minute Premiums and GPS-Based Pricing provide an extra incentive to reduce peak-period driving they can provide extra congestion and pollution reduction benefits. This might justify partial subsidy of these options, depending on the value placed on these incremental benefits. However, more research is needed to evaluate the incremental costs, travel impacts and social benefits.

Distance-based insurance pricing has two different types of effects on consumers. It provides savings to motorists who currently drive less than their price-group average, which represents a reduction in their current cross-subsidies to higher-mileage motorists within their price group. These are economic transfers that are justified on equity grounds. In addition, there are overall savings and benefits that result as motorists reduce their mileage, which reduce total crash costs, insurance costs, congestion, road and parking facility costs and environmental impacts. These are resource cost savings, which are justified on economic efficiency grounds.

There is likely to be strong support for *optional* distance-based insurance pricing since it increases consumer choice and gives individual motorists a new opportunity to save money. Consumers are accustomed to being able to choose from various rate structures for many types of goods, such as telephone service, Internet service and air travel. If cross-subsidies are not allowed between the different pricing pools, an increasing portion of motorists would switch to it over time.

There is mixed public support for *mandatory* distance-based insurance. Citizens generally support pricing that increases fairness and affordability, and helps solve specific problems, but are skeptical of reforms that may be less convenient, increase costs, or burden certain groups. PATP appears to be the least popular option. Usage-Based Premiums appears to have about equal levels support and opposition, with responses affected by the concept is presented. If described as a reward to consumers who use alternative modes it tends to have a positive response, but if presented as a surcharge on higher-mileage motorists it tends to have a more negative response.

Under some circumstances consumers seem to prefer fixed prices, because they are predictable and minimize transaction costs. However, this preference appears to be weak. Fixed-rate pricing is relatively uncommon in competitive markets, and some markets are shifting toward more marginal pricing. There is no evidence that consumers have a strong preference for fixed-priced insurance. Given the choice, most motorists who expect to save money would probably choose optional distance-based insurance.

Many of the concerns raised about distance-base pricing reflect misunderstanding of the concept, and so can be addressed with public education. Insurers have five legitimate financial concerns about distance-based insurance.

1. It is possible that the mileage foregone will be lower than average risk. As a result, premium revenue could decline more than claim costs.
2. Optional distance-based pricing could attract motorists with relatively high per-mile claim costs.
3. With optional distance-based pricing, motorists in multi-vehicle households could shift driving from vehicles with distance-based premiums to those with fixed premiums.
4. Total premiums would probably decline, assuming distance-based pricing is successful at reducing claims. Although revenue reductions would be offset by reduced claim costs, this would reduce investment income, which could reduce insurance company profits.
5. Some motorists may try odometer fraud to steal insurance. However, odometers are increasingly tamper-resistant, and most types of fraud could be detected during annual audits and crash investigations. Odometer auditing should provide data comparable in accuracy to that used in other common commercial transactions.

Offsetting these financial risks is the fact that a percentage reduction in mileage usually provides a proportionally greater reduction in claims. Available empirical evidence suggests that each 1% reduction in mileage typically causes a 1.4-1.8% reduction in claims, making insurers financially better off. This increases the net savings from distance-based pricing and reduces the financial risks to insurers.

These concerns can be addressed by implementing distance-based pricing pilot projects to obtain information on feasibility, costs, consumer demand, travel impacts, crashes, and revenue impacts. These could start small, and if no major are encountered they could expand until all motorists are offered distance-based pricing.

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