Victoria Transport Policy Institute
www.vtpi.org litman@vtpi.org
1250 Rudlin Street, Victoria, BC, V8V 3R7, CANADA
Phone & Fax (250) 360-1560
"Efficiency - Equity - Clarity"

DISTANCE-BASED VEHICLE INSURANCE
FEASIBILITY, COSTS AND BENEFITS
Appendices
7 August 2001

Appendix 1
Evaluation Criteria

This appendix discusses the criteria used to evaluate insurance pricing options.

MARKET PENETRATION

This refers to the portion of total vehicle insurance premiums made distance-based. Market penetration is affected by several factors, including whether programs are voluntary or mandatory, and whether they apply to some or all types of coverage. Market penetration of optional distance-based pricing us affected by which types of motorists would consider it attractive and by the marketing efforts made to attract customers. Market penetration is likely to increase over time as more motorists become familiar with distance-based pricing.

ACTUARIAL ACCURACY

Actuarial science concerns the current financial implications of future contingent events.[1] Actuarial accuracy refers to how well insurance pricing reflects the insurance costs imposed by each policy. Actuarial accuracy is desirable for two reasons. First, it is generally considered fairest (horizontally equitable) that individual motorists pay premiums that reflect the crash costs they impose, unless a subsidy is specifically justified.

The second justification is broadly termed "economic efficiency." Economic efficiency requires that prices reflect costs so consumers have an incentive to choose an optimal level of risk, and have an incentive to reduce crash costs. For example, if all motorists paid the same insurance premiums regardless of their crash costs, some motorists might take excessive risks. Society is generally better off making insurance premiums accurately reflect risks so individuals perceive a higher premium whenever they increase their crash risk, and perceive an incremental savings whenever they reduce their risk.

Actuarial accuracy is a matter of degree. Insurance pricing can never be perfectly actuarially accurate, since this would require perfect knowledge of future events. Actuarial accuracy can also be limited by administrative costs of adding additional rating factors and gathering more detailed information. In additional to these technical limitations, insurance pricing may also be constrained by political and marketing objectives.

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[1] *Foundations of Casualty Actuarial Science,* 3rd Edition, Casualty Actuarial Society (Arlington; www.casact.org), 1996, p. 1.

IMPLEMENTATION COSTS

Implementation costs include incremental "transition" and "transaction" costs to users, businesses and government agencies. Transition costs are temporary, such as the costs of establishing new procedures or marketing a new concept. Transaction costs are ongoing costs, such as financial and time costs of additional inspections or equipment needed for each vehicle. Note that there may also be incremental savings that offset some of these incremental costs. It is the net costs that are important for analysis.

EQUITY

There are several types of equity related to insurance pricing.[2]

Horizontal Equity

Horizontal equity refers to whether users are treated equally. In general, this means that "you get what you pay for and pay for what you get," since any other price structure results in cross subsidies that transfer costs from some consumers to others. Horizontal equity requires actuarial accuracy, as previously described.

Current insurance pricing is horizontally inequitable because within existing price categories, lower-mileage motorists overpay and higher-mileage overpay their true insurance costs. It is also horizontally inequitable due to significant cross subsidies from low-risk to high-risk motorists needed to provide "affordable" unlimited-mileage coverage to higher-risk motorists. To the degree that price changes reduce these subsidies they increase horizontal equity.

Vertical Equity With Respect To Income

Vertical equity refers to whether the allocation of benefits and costs favors people with greater needs. It is often measured according to how benefits and costs are allocated with respect to wealth. Costs that represent a greater portion of income for low-income households than for high-income households are considered regressive, even if higher income households pay more in absolute terms.

Available evidence indicates that distance-based pricing is relatively progressive (i.e., it reduces the regressivity off existing pricing). Vehicle insurance is a regressive cost. One study found that the three lowest income groups of motorists spent an average of 32%, 14% and 7% of household income on vehicle insurance respectively, compared with 2% for motorists overall.[3] Annual mileage tends to rise with income, as illustrated in figures A-1 to A-3. A model based on the 1995 NPTS suggests that a 10 percent increase in household income increases daily VMT by approximately 3.6 percent.[4] This indicates that fixed insurance pricing tends to cause lower-income motorists to subsidize the insurance costs of higher-income motorists in their price category. Few low-income households drive their vehicles more than the fleet average (about 12,500 miles per year), so most lower-income drivers would save money with distance-based pricing. It would also allow some lower-income households to afford a vehicle that is currently unaffordable due to high fixed insurance charges.

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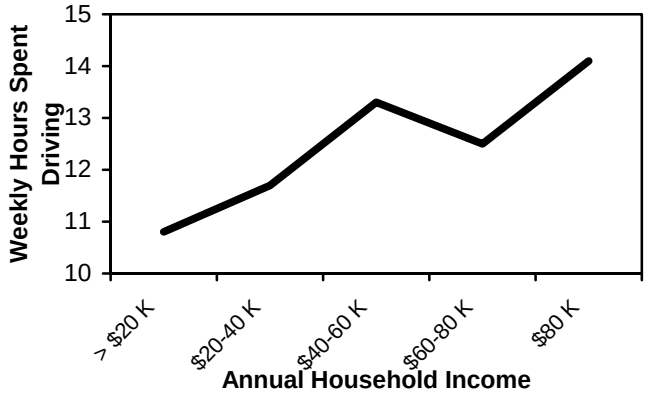
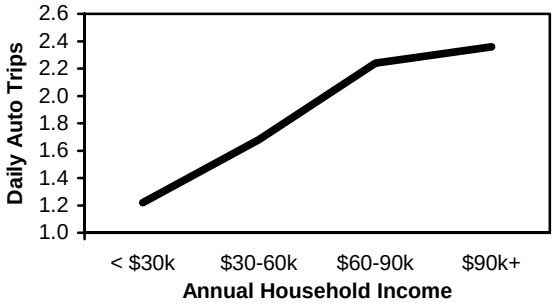
[2] Todd Litman, *Evaluating Transportation Equity*, VTPI (www.vtpi.org), 1999.
[3] Robert Lee Maril, *The Impact of Mandatory Auto Insurance Upon Low Income Residents of Maricopa County, Arizona*, National Associattion of Independent Insurers, 1994, cited in Khazzoom, 1999.
[4] Pickrell, Don and Paul Schimek, "Trends in Personal Motor Vehicle Ownership and Use: Evidence from the Nationwide Personal Transportation Survey," U.S. DOT Volpe Center, April 23, 1998.

Figure A-1 **Average Weekly Driving By Income**[5]



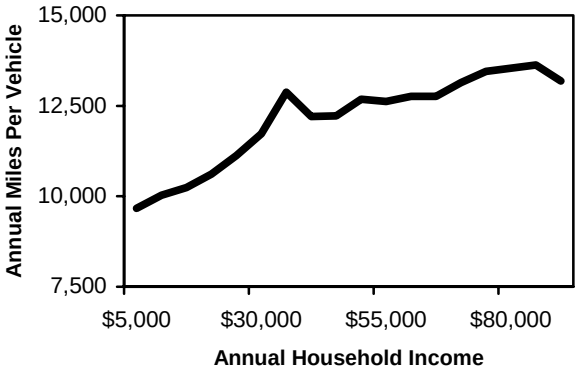
Vehicle travel increases with income, particularly in the lower-income range.

Figure A-2 **Average Daily Automobile Trips Per Person by Income**[6]



Per-capita travel increases with income.

Figure A-3 **Average Annual Vehicle Mileage By Income**[7]



Per-vehicle travel increases with income.

[5] ICBC market survey data, August 1998.
[6] 1994 Trip Diary Survey, GVRD (Burnaby).
[7] 1995 NPTS, Federal Highway Administration, USDOT (www-cta.ornl.gov/gcgi/npts), 1998.

The progressivity of distance-based pricing is probably greater than these values indicate because lower income consumers value financial savings more than higher-income consumers, so they are also likely to reduce their vehicle travel more than average and enjoying relatively large gains in consumer surplus.

Some critics argue that distance-based insurance could harm some types of economically disadvantaged motorists, such as lower-income rural and suburban residents with long-distance commutes. However, these motorists as a group are unlikely to pay more under distance-based insurance, since commuting represents a minor portion of total vehicle mileage, and distance-based insurance pricing takes into account the higher average annual mileage of suburban and rural residents (except Pay-at-the-Pump). Only motorists who drive more than average *in their rate category* would pay more. Rural motorists could typically drive up to 15,000 kilometres per year without paying more for insurance than they do now (as discussed in the next section).

This is not to say that every low-income motorists would save with distance-based pricing, but the number of lower-income motorists who are made worse off is likely to be far smaller than the number that is better off. The ratio between gainers and losers is likely to inverse with respect to income, with the greatest portion of gainers in the lowest income categories, because low-income motorists already drive their vehicles less than average, and they place a high value on opportunities to save money. All available evidence indicates that distance-based insurance tends to be progressive with respect to income.

Fixed-priced insurance relies on cross-subsidies to make unlimited-mileage coverage affordable to high-risk motorists, and so requires a tradeoff between horizontal and vertical equity objectives.[8] Distance-based insurance takes a different approach to affordability. It allows motorists to control insurance costs by limiting consumption, as with most other goods.

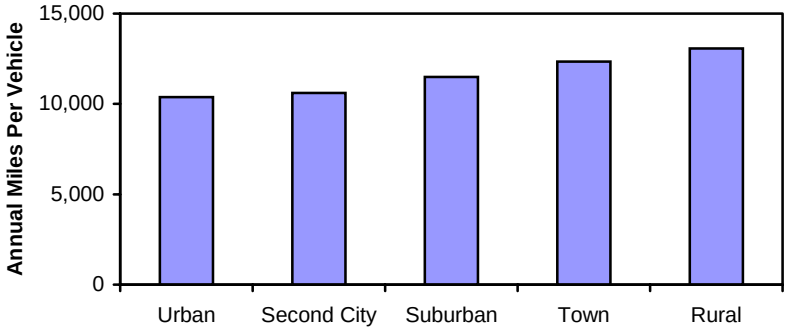
Geographic Equity

A common concern raised about any change in vehicle pricing is the different impacts that may be experienced in different geographic areas. In particular, rural and suburban residents tend to drive more than urban residents, as shown in Figure A-4. Rural residents also have lower average per-mile crash rates, so annual premiums tend to be lower for rural vehicles.

Distance-based pricing that fails to take into account geographic factors (such as Pay-at-the-Pump) could overcharge rural residents and undercharge urban residents relative to their actual insurance costs, but distance-based pricing that incorporates geographic differences in annual mileage and crashes would not. For example, rural residents might pay 3¢ per mile for coverage that would cost 5¢ per mile for urban residents with otherwise comparable rating factors, just as urban motorists currently pay higher vehicle-year premiums.

[8] Even this is regressive since higher-income motorists drive more than average and so gain the majority of subsidies.

Figure A-4 **Average Annual Miles by Geographic Location**[9]



Average per-vehicle mileage is higher for residents in lower-density areas.

1. Gender Discrimination

Some researchers argue that current insurance pricing is inequitable with respect to gender.[10] Males tend to drive about 40% more than female motorists, and have approximately 40% more insurance claims per vehicle year, but insurers are discouraged from using gender as a rating factor. Distance-based vehicle insurance addresses this problem by focusing on differences in travel rather than gender. For this reason, the U.S. National Organization for Women (NOW) has lobbied in support of usage-based vehicle insurance for more than a decade.

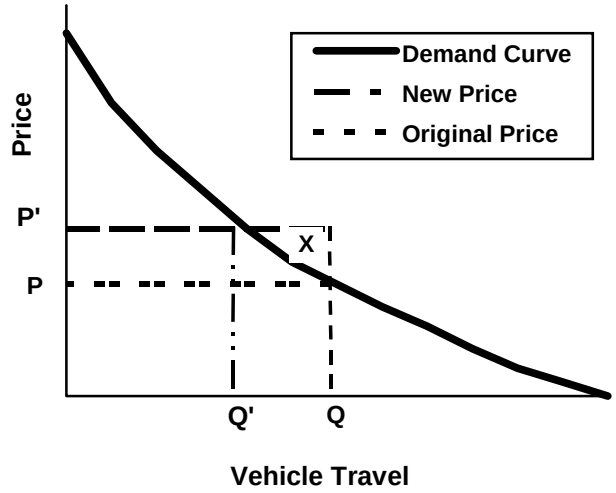
The Canadian Supreme Court has concluded that until a suitable alternative is available, discriminatory pricing is acceptable. Summarizing the court's judgment, Dr. R. Brown writes, "*the insurance industry must be allowed time to determine whether it could restructure its classification system in a manner that would eliminate discrimination based on enumerated group characteristics and still reflect the disparate risks of different classes of drivers.*"[11] The court concluded that it would be inappropriate to find a particular practice illegal when no reasonable alternative existed. This suggests that if distance-based pricing is demonstrated to be technically feasible, it could be legally mandated in Canada as a way to reduce existing discrimination against women and other lower-mileage groups.

[9] *1995 National Personal Transportation Survey*, USDOT (www-cta.ornl.gov/cgi/npts), 1998.
[10] Butler, Butler and Williams, "Sex-Divided Mileage, Accident, and Insurance Cost Data Show That Auto Insurers Overcharge Most Women," *Journal of Insurance Reg.*, Vol. 6, No. 3 & 4, 1988, p. 379.
[11] Robert Brown, "Recent Canadian Human Rights Decisions Having an Impact on Gender-based Risk Classification Systems," *Journal of Actuarial Practice*, Vol. 3, No. 1, 1995, p. 175.

CONSUMER BENEFITS[12]

Distance-based insurance can directly increase consumer welfare by allowing motorists who reduce their mileage a new opportunity to save money. Consumers would forego vehicle travel when doing so makes them better off overall (i.e., when the incremental travel benefits are worth less than their incremental financial savings). Vehicle travel reductions therefore represent net consumer benefits. The gain in consumer surplus is represented by triangle X in Figure A-5, the average value of which is estimated by dividing total incremental financial savings by half.[13] This is in addition to indirect consumer benefits such as reduced congestion, crash risk and pollution emissions.

Figure A-5 **Vehicle Travel Demand Curve**



Distance-based insurance increases the Price of driving (although total costs do not increase) from **P** *to* **P'**, *reducing vehicle travel from* **Q** *to* **Q'**. *Triangle* **X** *represents consumer surplus gained, which is approximately half the total financial savings.*

Put another way, consumers currently have only two choices: not own a vehicle, or own a vehicle and pay for unlimited-mileage insurance. Distance-based insurance offers a third choice, own a vehicle but limit its use to minimize insurance costs. This makes insurance and vehicle ownership more affordable and increases consumer choice. For example, it allows motorists to afford an extra vehicle that is seldom used, such as an old truck for errands or a recreational vehicle that is used only a few times a year. Consumers are generally better off by having more choices. They can purchase just what they need, but are not forced to pay for coverage they don't need. Although they consume less, they are better off.

[12] For a more technical discussion see, 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.

[13] This is what transportation economists call the "Rule-of-Half." See *Manual on User Benefit Analysis of Highway and Bus Transit Improvements*, AASHTO, 1977, p. 26.

Uninsured Driving[14]
In some parts of North America, a significant portion of vehicles are uninsured. Studies comparing the number of vehicles registered with the number of vehicles insured often find that more than 20% of vehicles carry no insurance. However, this analysis exaggerates the problem, since some of these vehicles are legally uninsured, including, for example, farm vehicles that are never driven on public roads and vehicles that are not in working order. One study found that only half of the 5.3 million uninsured vehicles in California could be considered illegally uninsured.[15] Analysis of the ratio between uninsured insurance claims and total bodily injury insurance claims indicates that about 13% of total driving is uninsured.[16] However, this includes hit-and-run collisions, which may include many insured drivers who want to avoid responsibility, so the actual portion of uninsured driving is probably far less than 13%.

The largest group of uninsured drivers consists of low-income motorists who cannot afford insurance, although they need their automobiles, often for work.[17] Many of these motorists would need to pay high premiums because they live in high-rated territories and do not quality for discounts (not because they have had a claim or traffic violation, but simply because they have not purchased insurance in the recent past). Many low-income households must spend 10-20% of their household income to be legally insured. The combination of low incomes and high rates make current insurance unaffordable. Yet driving is often the only travel options for jobs and education. For this reason, public officials and advocates for the poor often discourage enforcement of vehicle insurance requirements.

PATP is advocated as a way to eliminate uninsured driving. However, some of this driving may be with fuel purchased in other jurisdictions or illegally (as much as 10% under some circumstances, as described in Appendix 3). Thus, although PATP increases insurance coverage, it does not eliminate the problem of motorists failing to pay their fair share of insurance costs. Rather than uninsured drivers imposing uncompensated costs on other road users when a crash occurs, PATP could result in some motorists imposing uncompensated costs on other motorists when they evade the surcharges. These are likely to be of comparable magnitude.

PUBLIC ACCEPTABILITY

Public acceptability is an important consideration in determining the political and market feasibility of a pricing option. The results of various surveys and other indicators of public acceptability of distance-based pricing are described in the body of this report. Appendix 6 includes newspaper and magazine articles on distance-based pricing. There appears to be general public support for insurance pricing that is more equitable and affordable, but there also appears to be resistance to pricing that entails significantly more complexity, uncertainty or transition costs. There also appears to be general public support for programs that increase road safety, congestion reduction, consumer savings and choice, and environmental protection. Optional distance-based pricing is likely to have broad public support since most consumers support policies that increase their choices.

[14] 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.
[15] *California's Uninsured*, California Dept. of Insurance (Sacramento; www.insurance.ca.gov), 1998.
[16] *Uninsured Motorists*, All-Industry Research Advisory Council (Oak Brook, IL), 1989.
[17] *California's Uninsured*, Op. Cit., 1998.

TRAVEL IMPACTS

There is abundant empirical evidence that pricing affects travel behavior.[18] Even a small parking fee or road toll tends to change trip destinations, and drivers often go out of their way to save a few cents per litre in fuel costs. This price sensitivity is measured in "elasticity" values: the percentage change in consumption resulting from each 1% change in price. Table A-1 summarizes typical travel elasticity values. It indicates, for example, that a 10% fuel price increase tends to reduce vehicle travel by about 2-3%, increase vehicle fuel efficiency by 4%, and reduce vehicle fuel consumption by 7%.

Table A-1 **Estimated Long-Run Transportation Elasticities**[19]

Estimated Component	Fuel Price	Income	Taxation (Other than Fuel)
Car Stock	-0.20 to 0.0 (-0.1)	0.75 to 1.25 (1.0)	-0.08 to -0.04 (-0.06)
Mean Fuel Intensity	-0.45 to -0.35 (-0.4)	-0.6 to 0.0 (0.0)	-0.12 to -0.10 (-0.11)
Mean Driving Distance (per car per year)	-0.35 to -0.05 (-0.2)	-0.1 to 0.35 (0.2)	0.04 to 0.12 (0.06)
Car fuel demand	-1.0 to -0.40 (-0.7)	0.05 to 1.6 (1.2)	-0.16 to -0.02 (-0.11)
Car travel demand	-0.55 to -0.05 (-0.3)	0.65 to 1.25 (1.2)	-0.04 to 0.08 (0.0)

Numbers in parenthesis indicate the original authors' "best guess" values.

Price sensitivity tends to decline with income, but for most pricing options (excepting PATP) this is offset by the higher distance-based premiums that higher income motorists typically pay. For example, a lower-income motorist who purchases only basic liability insurance would typically pay about 3¢ per mile while a higher income motorist who purchases comprehensive coverage would typically pay 8¢ per mile. As a result, various income classes are likely to reduce their mileage by approximately the same amount.

Table A-2 shows the predicted change in vehicle travel resulting from a mileage fee. It indicates that a 2¢ per mile fee is likely to reduce vehicle travel by 3.5%, and a 4¢ mile fee reduces vehicle travel by 6.7%. Since drivers perceive their variable cost to average about 10¢ per mile, this reflects an elasticity of about –0.2 to –0.25, which is consistent with other travel elasticity estimates.

[18] Tae Hoon Oum, W.G. Waters II, and Jong-Say Yong, "Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates, *Journal of Transport Economics*, May 1992, pp. 139-154. ICF Incorporated, *Opportunities to Improve Air Quality Through Transportation Pricing Programs*, USEPA (Washington DC; www.epa.gov/omswww/market.htm), Sept. 1997; *Curbing Gridlock*, Transportation Research Board (Washington DC), Special Report 242, 1994, pp. 89-114; Goodwin, "Review of New Demand Elasticities," *Journal of Transport Economics*, May 1992, pp. 155-163; VTPI, "Transportation Elasticities," *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org), 2001.

[19] Olof Johansson and Lee Schipper, "Measuring the Long-Run Fuel Demand for Cars," *Journal of Transport Economics and Policy*, Vol. 31, No. 3, 1997 p. 290.

Table A-2 **Predicted Travel Reduction from Per-Mile Fees**[20]

Fee	Travel Reduction
1¢	-1.8%
2¢	-3.5%
3¢	-5.1%
4¢	-6.7%
5¢	-8.2%
6¢	-9.7%
7¢	-11.2%
8¢	-12.5%
9¢	-13.9%
10¢	-15.2%

Distance-based insurance makes ownership of a low annual-mileage vehicle more affordable. Insurance is a particularly large portion of the costs of an inexpensive vehicle, which can often be purchased for less than annual insurance charges. As a result, distance-based pricing could increase total vehicle ownership by about 1%.[21] Since vehicle ownership is near saturation for middle-class drivers, most of this increase is likely to consist of second vehicles, such as an old truck for errands or a recreational vehicle, and so would often substitute for, rather than add to, travel by existing vehicles. Only drivers who would purchase their first vehicle due to increased affordability are likely to drive significantly more, and these vehicles would be driven relatively low annual kilometres (otherwise, distance-based pricing would not make them more affordable). As a result, this 1% increase in vehicle ownership should cause a small (perhaps 0.1-0.3%) increase in vehicle travel among those motorists, which would be overwhelmed by reductions in travel by existing vehicle owners.

The travel reduction impacts of distance-based insurance can be expected to increase with implementation of complementary TDM strategies such as transit improvements, ridesharing programs, telecommuting, Smart Growth, etc.).[22]

[20] Elizabeth Deakin and Greig Harvey, "The STEP Analysis Package," in *Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions*, USEPA (Washington DC; www.epa.gov/omswww/market.htm) September 1997, Appendix B, Table B.21, adjusted to account for 30% inflation between 1991 and 2001.

[21] Using Johansson and Schipper's estimate that the elasticity of vehicle ownership with respect to non-fuel taxes is –0.06, and assuming that insurance represents 20% of total vehicle ownership costs.

[22] COMSIS, *Implementing Effective Travel Demand Management Measures*, Institute of Transportation Engineers (Washington DC; www.ite.org), 1993; Reid Ewing, *Transportation and Land Use Innovations; When You Can't Build Your Way Out of Congestion*, Planners Press (Chicago), 1997.

ROAD SAFETY (CRASHES AND CRASH COSTS)

Road safety can be evaluated in different ways: total crashes; per-resident, per-vehicle or per-mile crash rates; injury and fatality rates; crash costs; insurance claims; and insurance compensation costs.[23] From an insurer's perspective, changes in claim compensation costs are the most important criteria, but crashes also cause significant uncompensated costs to society, including nonmonetary damages to drivers found to be culpable, and most losses to a fatality victim who has no dependents. In other words, reducing crashes has greater value to society than simply the avoided insurance claims. Several studies have developed monetized estimates of vehicle crash costs.[24] Table A-3 summarizes U.S. 1997 crash cost information.

Table A-3 **U.S. Crash Data and Estimated Crash Costs (1997)** [25]

	All Vehicles	Passenger Cars	Light Trucks/Vans	Single Unit Trucks	Motor-cycles
Police Reported Crashes	6,261,000	5,307,000	2,209,000	154,000	89,000
Minor-Moderate Injuries	3,433,000	3,020,000	1,183,000	65,000	78,000
Serious-Fatal Injuries	194,000	146,000	65,000	5,000	15,000
Per 100 Million VMT	500	556	416	289	928
Per 1000 Veh. (annual)	59	65	48	36	22
Comprehensive Cost Per Crash	$52,610	$50,190	$50,750	$66,370	$206,460
Comprehensive Cost Per VMT	$0.197	$0.248	$0.247	$0.215	$2.331
Comprehensive Cost Per Veh. Year	$2,340	$2,900	$2,850	$2,720	$5,410

This summarizes crash data. Additional information is provided in the original table.

For this analysis, uncompensated crash cost savings are estimated at 6¢/mile reduced, assuming 8¢/mile total crash costs of which 25% are compensated by insurance. This is considered a lower-bound estimate.

[23] "TDM Safety Benefits," *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org), 2001.
[24] Ted Miller, Urban Institute, *The Costs of Highway Crashes*, FHWA (Washington DC), pub. No. FHWA-RD-055, 1991; Lawrence J. Blincoe, *Economic Cost of Motor Vehicle Crashes 1994*, NHTSA, USDOT (Washington DC; www.nhtsa.dot.gov/people/economic/ecomvc1994.html); David Forkenbrock, Norman Foster and Thomas Pogue, *Safety and Highway Inve$tment*, Midwest Transportation Center (Iowa City), June 1994; Ulf Persson and Knut Ödegaard, "External Cost Estimates of Road Traffic Accidents; An International Comparison" *Journal of Transport Economics and Policy*, Sept. 1995, pp. 291-304; Keith Vodden, et al, "*The Social Cost of Motor Vehicle Crashes in Ontario*, Ministry of Transportation Ontario, Safety Policy Branch, March 1994.
[25] Jing-Shiarn Wang, Ronald R. Knipling and Lawrence J. Blincoe, "The Dimensions of Motor Vehicle Crash Risk, *Journal of Transportation and Statistics*, Vol. 2, No. 1, May 1999, pp. 19-43.

ENERGY CONSUMPTION AND POLLUTION REDUCTION.

Motor vehicles produce several harmful pollutants, including local air pollutants (particulates, NOx, VOC, CO), global air pollutants (CO_2 and CFCs), water pollution, and noise. A number of studies have estimated monetized values of these emissions and the benefits of pollution reductions.[26]

Mark Delucchi, *et al.*, estimate the human health costs of motor vehicle air pollution as summarized in Table A-5. Additional costs include $2-4 billion annually in ozone damage to commercial agriculture,[27] and $5-40 billion in reduced visibility.[28]

Table A-5 **Air Pollution Health Costs by Motor Vehicle Class ($1990 / VMT)**[29]

Vehicle Class	Low Estimate	Middle Value	High Estimate
Light Gasoline Vehicle	0.008	0.069	0.129
Light Gasoline Truck	0.012	0.100	0.188
Heavy Gasoline Vehicle	0.024	0.260	0.495
Light Diesel Vehicle	0.016	0.121	0.225
Light Diesel Truck	0.006	0.061	0.116
Heavy Diesel Truck	0.054	0.644	1.233
Weighted Fleet Average	*0.011*	0.112	*0.213*

The FHWA uses the following air pollution cost estimates in the *1997 Federal Highway Cost Allocation Study*, in 1990 U.S. dollars.

Table A-6 **Air Pollution Costs**[30]

Vehicle Class	Total ($1990 Million)	Cents per Mile
Automobiles	$20,343	1.1¢
Pickups/Vans	$11,324	2.6¢
Gasoline Vehicles >8,500 pounds	$1,699	3.0¢
Diesel Vehicles >8,500 pounds	$6,743	3.9¢

For this analysis we assume total pollution costs (including air and noise pollution) average 2¢ per vehicle mile, plus 8¢ per gallon of fuel consumed to account for global warming, water pollution, and other fuel-related pollution.

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[26] Todd Litman, *Transportation Cost Analysis; Techniques, Estimates and Implications*, Victoria Transport Policy Institute (Victoria; www.vtpi.org), 1998.
[27] Mark Delucchi, James Murphy, Jin Kim, and Donald McCubbin, *Cost of Crop Damage Caused by Ozone Air Pollution From Motor Vehicles*, UC Davis, ITS (www.engr.ucdavis.edu/~its), 1996.
[28] Mark Delucchi, James Murphy, Donald McCubbin and Jin Kim, *Cost of Reduced Visibility Due to Particulate Air Pollution From Motor Vehicles*, UC Davis, ITS (www.engr.ucdavis.edu/~its), 1996.
[29] Donald McCubbin and Mark Delucchi, *Social Cost of the Health Effects of Motor-Vehicle Air Pollution*, UC Davis, ITS (www.engr.ucdavis.edu/~its), 1996, Table 11.7-6. Also see Mark Delucchi, "Environmental Externalities of Motor-Vehicle Use in the US," *Journal of Transportation Economics and Policy*, Vol. 34, No. 2, May 2000, pp. 135-168.
[30] FHWA, *1997 Federal Highway Cost Allocation Study Final Report Addendum*, Federal Highway Administration, USDOT (www.ota.fhwa.dot.gov/hcas/final), 2000, Table 12.

ECONOMIC EFFICIENCY AND DEVELOPMENT

Broad price reforms can be evaluated based on the degree to which they encourage economic efficiency and minimize market distortions.[31] Economic efficiency refers to whether resources are used to provide the greatest possible social benefit. Economic efficiency requires that price equals marginal cost. This gives consumers the incentive to use resources optimally.

Price distortions are cumulative. Underpriced insurance not only increases crash costs beyond what is optimal, it also increases congestion and roadway costs, and reduces economic productivity. Conversely, transportation price reforms can provide a variety of benefits by reducing other external costs, as discussed below.

Traffic congestion reduction.
Any strategy that reduces VMT tends to reduce traffic congestion, although predicting exact impacts require modeling that takes into account various factors that are unique to each geographic area. One major modeling study found that a 2¢ U.S. per mile mileage charge would reduce total vehicle travel by about 3.9-4.2%, but congestion delays would decline by 7.5-10.5%.[32] In other words, congestion delay reductions were approximately twice as large as vehicle travel reductions. Edlin also suggests that a modest reduction in VMT can provide a proportionally larger reduction in congestion delays.[33]

A number of studies estimate typical external congestion costs imposed by each additional vehicle on a roadway.[34] Table A-7 summarizes the findings of one such study. It implies that a reduction in highway travel provides benefits that are probably worth several cents per vehicle mile. For this study we use a basic congestion reduction benefit of 4¢ per mile avoided, increased by 10% for Per-Minute Premiums, and 30% for GPS-Based premiums, because they provide an extra incentive to reduce driving under congested conditions.

Table A-7 **Estimated Highway Congestion Costs**[35] (1997 U.S. Cents Per Vehicle Mile)

	Rural Highways			**Urban Highways**			**All Highways**		
	High	Med.	Low	High	Med.	Low	High	Med.	Low
Automobile	3.76	1.28	0.34	18.27	6.21	1.64	13.17	4.48	1.19
Pickup & Van	3.80	1.29	0.34	17.78	6.04	1.60	11.75	4.00	1.06
Buses	6.96	2.37	0.63	37.59	12.78	3.38	24.79	8.43	2.23
Single Unit Trucks	7.43	2.53	0.67	42.65	14.50	3.84	26.81	9.11	2.41
Combination Trucks	10.87	3.70	0.98	49.34	16.78	4.44	25.81	8.78	2.32
All Vehicles	4.40	1.50	0.40	19.72	6.71	1.78	13.81	4.70	1.24

[31] "Market Principles," *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org), 2000.
[32] Elizabeth Deakin and Greig Harvey, *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy, and Equity Impacts*, Calif. Air Resources Board (Sacramento), 1996. 7-16.
[33] Aaron Edlin, *Per-Mile Premiums for Auto Insurance*, Dept. of Economics, University of California at Berkeley (http://emlab.berkeley.edu/users/edlin), 1999, p. 31.
[34] *Quantifying Congestion; Final Report and User's Guide*, Transportation Research Board (Washington DC), NCHRP Project 7-13, 1997; Miller and Li, *An Investigation of the Costs of Roadway Traffic Congestion*, California PATH, UCB, Berkeley, 1994; Small, *Urban Transportation Economics*, Harwood (Chur), 1992, pp. 85-94.
[35] *1997 Federal Highway Cost Allocation Study*, USDOT, Table V-23.

Facility cost savings.
Reduced vehicle mileage can reduce road and parking facility costs. Table A-8 summarizes estimates of roadway external costs. In a detailed analysis, Mark Delucchi estimates that off-street parking costs include $48 to $162 billion for business supplied parking and $12 to $20 billion for municipal and institutional supplied parking, and that unpriced, non-residential, off-street parking has a total value of $148 to $288 billion (in 1991 U.S. dollars).[36] This averages $788 to $1,531 per motor vehicle year, or 6.3¢ to 13.3¢ per motor vehicle mile (in 1991 dollars). This study uses a conservative facility cost savings value of 3¢ per vehicle mile, with higher values for Per-Minute and GPS-based pricing because they provide an extra incentive to reduce driving under urban-peak conditions.

Table A-8 **Roadway Cost Responsibility Per Mile (Year 2000)**[37]

Vehicle Class	VMT (million)	Federal Costs	State Costs	Local Costs	Total Costs	Total User Payments	External Costs
Automobiles	1,818,461	$0.007	$0.020	$0.009	$0.035	$ 0.026	$0.009
Pickups and Vans	669,198	$0.007	$0.020	$0.009	$0.037	$ 0.034	$0.003
Single Unit Trucks	83,100	$0.038	$0.067	$0.041	$0.146	$ 0.112	$0.034
Combination Trucks	115,688	$0.071	$0.095	$0.035	$0.202	$ 0.157	$0.044
Buses	7,397	$0.030	$0.052	$0.036	$0.118	$ 0.046	$0.072
All Vehicles	*2,693,844*	*$0.011*	*$0.025*	*$0.011*	*$0.047*	*$ 0.036*	*$0.010*

Economic Development
Distance-based insurance pricing could have various impacts on a regional economy. Economic productivity could increase if distance-based pricing reduces traffic congestion, roadway and parking costs, crash and pollution damages or leads to more efficient land use. Vehicle ownership expenditures are not expected to change significantly, but fuel, repair and medical service expenditures should decline with reduced driving and crashes. These expenditures would not necessarily decline in absolute terms, under most scenarios distance-based pricing would reduce their growth rates.

Expenditures on fuel provide relatively little employment or economic development in most regions.[38] To the degree that distance-based pricing leverages a shift from petroleum expenditures to other goods with greater regional inputs it increases economic development.

Table A-9 **Regional Economic Impacts of $1 Million Expenditure**[39]

Expenditure Category	Regional Income	Regional Jobs
Automobile Expenditures	$307,000	8.4
Non-automotive Consumer Expenditures	$526,000	17.0
Transit Expenditures	$1,200,000	62.2

This table shows economic impacts of consumer expenditures in Texas.

[36] Mark Delucchi, *Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991*, Vol. 6, Institute of Transportation Studies (www.engr.ucdavis.edu/~its), 1996, UCD-ITS-RR-96-3 (6), 1997.
[37] *1997 Federal Highway Cost Allocation Study*, USDOT (www.ota.fhwa.dot.gov/hcas/final), based on data from tables II-6, IV-11, V-21.
[38] "TDM and Economic Development," *Online TDM Encyclopedia*, VTPI (www.vtpi.org), 2000.
[39] Jon Miller, Henry Robison & Michael Lahr, *Estimating Important Transportation-Related Regional Economic Relationships in Bexar County, Texas*, VIA Transit (San Antonio; www.viainfo.net), 1999.

SUMMARY

The table below summarizes the various evaluation criteria. Note that these criteria were selected to evaluate various specific objectives, reflecting institutional and political perspectives. They are not intended to be mutually exclusive. For example horizontal equity impacts overlap actuarial accuracy, as do some benefits result from reduced vehicle travel.

Table A-9 **Summary of Evaluation Criteria**

Criteria	Definition	How Quantified
Market Penetration	The portion of total vehicle insurance premium payments affected by a price change.	As calculated for each pricing option.
Actuarial Accuracy	How accurately premiums on each policy reflect its individual crash risk and therefore insurance costs.	As described for each pricing option.
Implementation Costs	Additional costs to insurance companies and consumers compared with the current pricing, including temporary transition costs and ongoing incremental transaction costs.	Specific estimates for each pricing option.
Equity	Horizontal equity requires that consumers pay the costs they impose. Vertical equity requires that disadvantaged groups be relatively better off.	Horizontal equity is indicated by actuarial accuracy. Vertical equity is indicated by the distribution of costs and benefits.
Consumer Benefits	The net increase in consumer surplus when the incremental benefits of foregone travel is subtracted from consumers' financial savings.	Half of consumer financial savings.
Affordability	Whether insurance becomes more affordable, particularly for lower-income households.	As described for each price option.
Public Acceptability	How willing citizens appear to accept an alternative price system.	Survey data as available.
Travel Impacts	Amount of motor vehicle travel reduced.	As modelled for each price option.
Crash Reduction	The number of total crashes, and particularly casualty crashes, that a strategy could reduce.	Total costs are estimated to be three times insurance compensation costs.
Congestion & Facility Cost Savings	The amount of traffic congestion delays and roadway facility costs that a strategy would reduce.	Congestion = 3¢/mile. Facilities = 3¢/mile
Energy Use & Emission Reduction	Amount of energy consumption and pollution emissions that a strategy would reduce.	2¢/mile plus 8¢ per gallon of fuel conserved.
Economic Efficiency and Development	The degree to which pricing increases economic efficiency, productivity and economic development.	As described for each pricing option.

This table describes the various evaluation criteria used in this study.

Appendix 2

Vehicle Operating Cost Estimates

This appendix discusses how vehicle cost values were estimated for analysis in this study.

Several publications provide vehicle operating cost estimates.[40] The American Automobile Association uses Runzheimer International data in its cost estimates, which reflect relatively new, high annual mileage vehicles. They assume a vehicle with a four-year operating life driven higher than average annual mileage, and so have relatively high depreciation, financing and insurance costs, and low maintenance costs compared with lifecycle analysis.

Table A-10 American Automobile Association Vehicle Cost Estimates[41]

	Medium Car (Cavalier LS)	**Large Car** (Taurus SE)	**Luxury Car** (Grand Marquis)	**SUV** (Blazer)	**Van** (Caravan SE)
Gas & oil	5.0¢	6.3¢	7.4¢	7.2¢	6.8¢
Maintenance	2.9¢	3.1 ¢	3.2¢	3.4¢	3.2¢
Tires	1.3¢	1.4¢	1.4¢	1.4¢	1.3¢
Operating costs/mile	*9.2¢*	*10.8¢*	*12.0¢*	*12.0¢*	*11.3¢*
Mileage-based depreciation/mile[42]	14.6¢	15.6¢	16.2¢	12.6¢	15.4¢
Marginal Costs/mile	*23.8¢*	*26.4¢*	*28.2¢*	*24.6¢*	*26.7¢*
Insurance	$912	$856	$933	$1,312	$950
License & registration	$175	$223	$279	$396	$379
Depreciation	$2,819	$3,294	$3,979	$3,556	$3,409
Financing	$598	$802	$1,040	$929	$885
Ownership costs/year	*$4,504*	*$5,175*	*6,231*	*$6,193*	*$5,623*

Vehicle costs are often divided into two major categories.

- *Fixed* (or ownership) costs, including depreciation and financing, insurance, registration and licensing fees, and leased parking, which are not affected by how much a vehicle is driven. These are the majority of total vehicle expenses, representing 70-80% of vehicle expenses according to estimates, such as those illustrated in the table below.
- *Variable* (or operating) costs are expenses considered directly affected by how much a vehicle is driven, including fuel, oil, tire wear, road tolls and short-term parking fees. These represent a relatively small portion of total vehicle expenses.

[40] Todd Litman, *Transportation Cost Analysis; Techniques, Estimates and Implications*, Victoria Transport Policy Institute (Victoria; www.vtpi.org), 1998, chapter 3.1; VTPI, "Transportation Costs," *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org), 2001.

[41] Runzheimer International *Your Driving Costs 1998*, American Automobile Association (Heathrow, FL), 1998. Also see *Your Driving Costs in Southern California*, SCAA (www.aaa-calif.com).

[42] These values are intended to apply only to mileage greater than 15,000 miles per year, but there appears to be no technical reason that such "excess" miles cause more wear-and-tear than other miles, so they are considered a lower-bound estimate of mileage-based depreciation.

For this study, three types of vehicles were defined, representing high-, average- and low-mileage, as summarized in Table A-11. The low-mileage automobile represents the type of car that a lower-income motorist would typically drive, with basic liability insurance coverage, and relatively high variable costs to represent the higher mileage-related maintenance and repair costs associated with older vehicles. The high-mileage vehicle has costs based on AAA cost values for an intermediate automobile, which is a lower-bound estimate since about half of new vehicles are vans, trucks and SUVs which tend to have higher costs. Fleet average values are the average of these two.

Table A-11 **Cost Values Used for Analysis**

	Low	**Average**	**High**
Average Annual Vehicle Miles	*6,000*	*12,500*	*18,000*
Fixed (excluding insurance)	$1,200	$2,600	$4,000
Insurance	$400	$700	$1,000
Vehicle Operating Costs (per mile)	18¢	14.5¢	11¢

Appendix 3

Estimate of Cross-Border and Illegally Untaxed Fuel Use

This appendix describes calculations of provincial revenue losses from PATP surcharges.

When fuel prices are significantly higher in one jurisdiction, motorists often shift a portion of fuel purchases to nearby jurisdictions. Table A-12 shows how price differences affect the portion of Vancouver area fuel purchased in Washington State. An 18¢ per litre PATP surcharge (a 27% price increase, resulting in a 40%+ total price differential) increases cross-border sales by 10-15 percentage points. Assuming that about 60% of BC drivers have access to borders comparable to the Vancouver area, a 18¢/liter PATP surcharge can be expected to shift 5-10 percentage points of BC fuel sales to other jurisdictions.

Table A-12 **Cross-Border Fuel Purchases 1989-1995**[43]

Year	Fuel Price Savings in Whatcom County	Lower-Mainland Fuel Purchased in Whatcom County
1989	40%	12.0%
1990	42%	17.9%
1991	40%	19.0%
1992	31%	17.0%
1993	29%	14.6%
1994	25%	11.1%
1995	28%	7.5%

A study of cross-border fuel purchasing in Europe found that the average Dutch driver trade-off distance to a cheaper gas station to be about 1¢ per litre of fuel per kilometre (about U.S. 4¢ per gallon per mile), while Italian and Norwegian drivers have 0.67 and 0.30 cent per liter per km, respectively.[44] Such cross-border fuel trips are highest if residents of high-tax jurisdictions have other reasons (such as jobs or shopping) to travel to lower-tax jurisdictions. The study found that motorist tend to overstate their financial savings from cross-border fuel purchases to the point that 5% of Dutch motorists living 30 kilometres from a border take the trouble to drive to another jurisdiction to purchase fuel even though they experience no net savings (their financial savings are entirely spent on additional travel).

This suggests that a 35¢ per gallon fuel surcharge could cause a significant amount of cross-border fuel purchases by motorists who live within about 30 miles of a jurisdiction that does not have such a surcharge. Gas stations in a PATP jurisdiction within about 10 miles of a border would lose so much business that most would probably close.

[43] KPMG & Litman, *Financial Incentives for Reduced Automobile Use*, B.C. Transportation Financing Authority (Victoria), 1996, p. 18.
[44] P. Rietveld, F.R. Bruinsma and D.J. van Vuuren, "Spatial Graduation of Fuel Taxes; Consequences for Cross-Border and Domestic Fuelling," *Transportation Research A*, Vo. 35, No. 5, (www.elsevier.com/locate/tra), June 2001, 433-457.

Motor vehicle fuel tax evasion is a widespread problem.[45] Untaxed fuel is illegal to use in motor vehicles, but is relatively easy to acquire. Such fuel is widely sold for industrial and farm equipment, boats, and home heating fuel (which can be used as diesel fuel). Enforcement of untaxed fuel violations is low. Evasion is likely to increase if PATP is implemented.

If illegal fuel use increases at the same rate as cross-border fuel purchases, an 18¢ per litre insurance surcharge could result in an additional 1-3% of total roadway travel using illegally untaxed fuel. This suggests that in a typical jurisdiction, a 35¢ per gallon PATP surcharge could cause 5-10 percentage points of total gasoline fuel sales to shift across borders or be illegal, resulting in direct surcharge and tax revenue losses, plus indirect economic losses due to retail activity and jobs lost to other jurisdictions.

[45] Dwight V. Denison, Robert J. Eger III, and Merl M. Hackbart, "Cheating Our State Highways: Methods, Estimates and Policy Implications of Fuel Tax Evasion," *Transportation Quarterly*, Vol. 54, No. 2, Spring 2000, pp. 47-58.

Appendix 4

Odometer Auditing[46]

This appendix provides a detailed description of odometer auditing.

Odometer audits involve the following tasks:

1. Check speedometer for indications of tampering (signs that the speedometer unit or its cover has been removed, and for marks on the counter face).
2. Record tire size and check that it is within the specified range.
3. Attach a small seal to the ends of mechanical odometer cables to indicate if it is removed.[47] This is unnecessary on most newer vehicles which have electronic speedometers which are integrated with the vehicle's engine computer.
4. Check odometer accuracy and calibrate with a dynamometer. (This step is optional, or could be performed on a spot-check basis. It requires little extra time for vehicles undergoing an emission test which uses a dynamometer.)
5. Record odometer reading and forward results to the vehicle licensing agency or insurance company database. This could be done electronically.

Odometer audits would 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 from $5 to $10 or less.[48] Automated systems could make the process easy and accurate. For example, inspectors could enter a vehicle's registration number into a computer which would produce a printed form with all relevant details associated with the vehicle (e.g., name of policyholder, plate number, insurance details, mileage history, mile or kilometre odometer, special notations, etc.). These can be reviewed by the inspector to ensure audits are properly performed and data are consistent. Conversions, calculations and checks to identify of aberrant readings could be automated.

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. Odometer auditor certification could be self-supporting through fees, as with other government certification programs. Odometer auditors could include emission inspection stations (in many urban areas motor vehicles are required to have such inspections just prior to registration and insurance renewals), and automobile repair and tune-up stations. Some insurance brokers might also be certified as a marketing strategy. Most odometer audits (85-95%) are expected to be performed in conjunction with scheduled maintenance at an incremental cost of about $4, with the remainder costing about $10.

[46] Patrick Butler, *Operation of an Audited-Mile/Year Automobile Insurance System Under Pennsylvania Law*, National Organization for Women Insurance Project (www.now.org), 1992.
[47] The ease of installing such seals varies depending on the vehicle.
[48] AirCare vehicle emission inspections currently cost $18, which involve far more equipment and time than would be required for odometer auditing.

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.

Vehicle manufactures has a strong interest in odometer accuracy since leasing, warranty and used vehicle transactions are based on odometer readings. Government agencies are also interested in odometer accuracy for legal and safety reasons. As a result, the automotive industry is implementing measures to increase odometer accuracy and security. Odometer inaccuracy is likely to be a minor problem under mileage-based pricing for the following reasons:

1. New vehicle odometers are increasingly accurate and 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 get the most use, the vehicles with the greatest incentive for fraud will have the most tamper-resistant odometers.
2. Most vehicle owners would have a relatively small incentive for fraud. Odometer tampering would save only $300-600, a tenth of what vehicle dealers typically gain. Most households could save more by bypassing their electric meters than by odometer tampering.
3. Private vehicle owners don't have ready access to "clockers." Amateurs often damage equipment or leave marks, resulting in high costs and penalties. Clockers could not broadly advertise their services for fear of being caught.
4. Penalties for odometer fraud are severe and odometer fraud investigation efforts could be increased.
5. Regular auditing and checking for signs of fraud during crash inspection can identify most types of tampering.
6. Evidence of tampering would void insurance. This would discourage odometer fraud and reduce insurers' financial exposure when fraud occurs.
7. 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 used vehicle dealers, resulting in an overall reduction in total odometer fraud.

Annual audits would prevent most tampering, and detect any tampering that does occur. The existence of the annual odometer records means that an odometer could only be rolled back to a maximum of the previous year's audit, thereby eliminating the potential for large fraud ("clockers" typically roll back odometers 50,000 miles.[49] Since the average automobile travels roughly 12,000 miles annually, about 8,000 miles would be the upper practical limit for an attempted rollback with distance-based insurance.

Mechanical accuracy.
Odometer mileage readings are calculated by counting wheel revolutions. A 1989 Society of Automotive Engineers study found that older, mechanical odometers typically have an

[49] "Odometer Tampering Reduced 90 Percent in Past Six Years." *Automotive Fleet*, February 1993, pp. 16-22; Bradford Wernle, "Feds say odometer fraud is soaring." *Automotive News*, July 1, 1996.

accuracy of ±4%.[50] Technical improvements have increased this accuracy. Electronic odometers, used in most vehicles since 1988, tend to have accuracies of ±1%.[51] Similarly, tire wear error estimations by the SAE study were based on the use of bias ply tires, which began to be phased out in the mid- to late-eighties. Modern steel-belted radial tires tend to provide much more accurate odometer readings.

Oversizing tires, which can result in a slight underreporting of mileage, can be controlled through odometer audits. Tire sizes are recorded on the odometer audit statement and any 'plus sizing' of tires[52] either requires certified odometer recalibration at the owner's expense or the application of a simple standardized formula which multiplies the policyholder's per mile rate by the average increase in tire circumference. Purposefully plus sizing tires to steal insurance offers little benefit to the policyholder. A 10mm plus sizing would typically save a motorist only $28 annually in insurance costs through the underreporting of mileage readings. However, the motorist would have to invest $500+ in a second set of tires and change them before and after the audits to avoid being caught. Furthermore, driving with oversized tires without a reassessment of insurance rates or a recalibration of the odometer could void the insurance. The plus sizing of tires would be easily detected by the police attending a collision or upon inspection of the vehicle. Similarly, there would be little incentive to overinflate tires to underreport mileage. A 6-psi increase in tire pressure results in less than a 1% reduction in actual mileage shown, or an average savings of $12 per year in insurance costs.[53] Overinflating tires compromises vehicle handling, provides a 'stiff' ride and causes tires to wear faster and unevenly.[54]

Tire wear overreports mileage and therefore tends to offset underreporting factors. SAE indicates tire wear to be the most significant factor in odometer reading errors, with a 3% difference between new and worn tires. Vehicle owners would have an incentive to keep their tires from reaching an excessive state of wear. This should improve the safety of the vehicle fleet since tires would be kept more adequately treaded.

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[50] *Factors Affecting Accuracy of Mechanically Driven Automotive Speedometer and Odometers*, SAE J862 JAN89, Society of Automotive Engineers, 1989.

[51] Rob MacGregor, Head Instructor of Automotive Programs at the British Columbia Institute of Technology, notes that the powertrain control module (PCM) on electronically-regulated cars receive thousands of data signals per kilometre, and are thus highly accurate. Data collected for the PCM are used for engine management, ABS brakes and speedometers in addition to odometers. MacGregor estimates that there is less than ±1% error in electronic odometers and that the automobile industry is moving towards using electronically-based odometers almost exclusively.

[52] Some vehicle owners choose to "plus size" their tires, meaning they replace their standard size tires with ones of a greater diameter, for aesthetic reasons. However, tire specialists advise against plus sizing beyond the vehicle's tire rating (indicated inside the door panel) because it diminishes vehicle performance and safety, interferes with electronic systems, and increases vehicle stress and wear. Plus sizing can lead to wheel-well rubbing (particular with full passenger loads), poor braking, cornering and handling, horizontal tire roll, reduced fuel efficiency, inaccurate speedometer indications and wrong signals being sent to the powertrain control module. Excessive wear and tear to the transmission and differential can require premature repairs of up to $1,500. Based on interviews with Trevor McMillan, Big O Tires, August 1998 and Rick Radwinski, Goodyear Tires, July 1998.

[53] Based on 20,000 km/year and $0.06 per km.

[54] Interview with Trevor McMillan, manager of Big O Tires on Broadway in Vancouver, July 28, 1998.

Typical odometer error falls within the range of acceptable limits for the operation of measurement equipment, particularly in the case of electronic odometers, which typically allow a tolerance of ±1% error in the manufacture of electricity and gas meters and an "in service" limit of error of ±3%.

Tampering.
There are several ways to tamper with odometers so they read less than true miles of travel, as summarized in Table A-13. Mechanical speedometer cables can be disconnected, although as a result the speedometer would not work, and this could be discovered during a crash investigation, resulting in loss of insurance coverage. Mechanical odometers can be rolled back. An increasing portion of vehicles have electronic speedometer cables and digital odometers, and manufactures have incorporated a number of design features that make odometer tampering difficult and easy to spot.

Odometer rollbacks can usually be detected with gear-driven odometers as the plastic retainer that holds the odometer wheels cracks once opened and digits are usually misaligned.[55] Digital odometers are even more difficult to rollback. The ROM (read-only memory) chips that record mileage are proprietary. Fraud would require a new ROM chips with a mileage reading greater than the last audit. A new instrument panel bearing a lower mileage could be obtained from a scrap yard, it would have to be an exact match with the needed mileage reading. Removal and installation of instrument panels requires breaking seals, and typically requires 2 hours of labor, at a cost of $300 or more.

Scripture[56] and Wernle[57] indicate that the problem of odometer tampering is most prevalent among dealers selling high-mileage, late-model used vehicles, some of whom pay professional "clockers" $100-300 per car to roll back odometers. The U.S. FBI estimates that 3 million vehicles have odometers rolled back annually, which typically increases the vehicles' resale value by about $4,000.[58] In contrast, when individuals or "amateurs" try clocking their own cars in order to qualify for extra warrantee work or avoid high mileage charges on leased vehicles, their efforts are usually detectable.[59]

[55] Les Shufelt, Discussion regarding odometer fraud with supervisor of odometer repairs at United Automotive Distributors (Vancouver), August, 1998.
[56] James E. Scripture, "Odometer Rollback Schemes," *FBI Law Enforcement Bulletin* 59.8, 1990, pp. 8-12.
[57] Bradford Wernle, "Feds say odometer fraud is soaring," *Automotive News* July 1, 1996, p. 1
[58] Bradford Wernle, "Feds say odometer fraud is soaring," *Automotive News*, July 1, 1996, p. 1; Telephone conversation with Richard Morris, Chief of the National Highway Traffic Safety Administration, odometer fraud division, 26 February 1998.
[59] Shufelt, August 1998.

Table A-13 Stealing Insurance[60]

	Measure Taken	Cost	Benefit	Indications/mitigative measures
Low reading odometer	• Increasing tire sizes or decreasing axle ratios causes odometer to actually read less than kms traveled. • Policyholder would have to change tires or adjust axle ratio after the initial audit and calibration, then switch back before next test. • Insert a "2 to 1 reducer" that will record only half the miles actually travelled .	• New tires and installation. • Mechanical adjustment of axle ratio. • Poor vehicle performance (increased operating costs); potential of costly repairs to transmission differential. • Loss of odometer accuracy for measuring distances. • Risk of fines and criminal prosecution.[61] • Switching drive axle gears require substantial effort and cost; most cars are now front wheel drive, making task even more difficult/expensive. • If a car with switched tire size (diameter) is in an accident, then tampering is apparent and insurance is void; therefore no insurance is "stolen". • Must attach "2-1 reducer" to odometer signal cable, only possible on makes that carry odometer signal on a discreet wire.	• LOW: Changing a car's tires from 175mm tires to 185mm would cause a reading of 20,000 km on an actual mileage of 20,466 km (thereby underestimating travel by 466 km or 2.3%).[62] At a 6cents/km premium, the resulting savings would be $27.97.[63] • Changing axle ratios would likely cost as much as, or more, than any insurance cost savings. • MEDIUM: up to 50% of distanced based insurance costs could be avoided.	• If low reading is a problem. • Tire size info at time of audit/calibration added to insurance card information; any change to tire size requires revision of insurance documents, without which insurance is void. • Warnings that larger tires void insurance without recalibration. • Seal could be attached to axle housing. • 2-1 reducers are easy to detect. Insurance would be void if spotted.

[60] Patrick Butler, *Operation of an Audited-Mile/Year Automobile Insurance System Under Pennsylvania Law*, National Organization for Women Publications (Washington DC), 1992; Discussion with Les Shufelt, Supervisor of Odometer Repairs, United Automotive Distributors (GM)," August 1998.

[61] For example, if a motorist is stopped for a traffic infraction, the insurance papers presented by to the police will indicate the mileage last audited, the amount of mileage for which the automobile is ensured, tire size, axle ratio and the like. Any deviations from this can be detected by the attending officer and if any insurance theft is detected, the motorist can be fined and criminally prosecuted for fraud.

[62] Discussions regarding odometer accuracy and integration of AirCare odometer audits with Clark Lim, Transportation Planner, Greater Vancouver Regional District Strategic Planning Department, August 1998.

[63] This calculation is based on the increased tire diameter added from changing tires. An increase in tire size from 175 to 185 mm at a 70% profile increases tire diameter by 14 mm and therefore total distance travelled per tire revolution. This calculation assumes a constant tire size, however, tire wear over time would actually result in a distance underestimation less than what is suggested above.

Odometer resetting/roll back (professional criminal)	• Experts turn back analogue odometers with a thin pick or adjust digital readings by tapping into the signal travelling to the engine block	• $100-150US for mechanical odometers and $250-300US for electrical odometers. • Risk of fines and criminal prosecution. • Tampering voids insurance. • Very difficult to do without being detected by trained eye.	• MEDIUM: rate multiplied by every km rolled back (e.g., 10,000 kms rolled back at $0.04/km equals $400). • Benefit is highest for high risk drivers in high rated territories.	• Cables must be detached (and hence seals broken) to remove odometer for rollback on mechanical models and most electrical models. • Auditors look for signs such as scratches (on the odometer, face dial or Plexiglas), cracked missing/loose screws, misaligned digits (especially 10,000 digit), vehicle or tire wear; odometer may "tick" while driving.[64] • Analogue odometers generally have a plastic tear strip (a "retainer") which "scars" from being removed. A broken retainer will prevent the odometer from lining up properly. • Increasingly, vehicles record the odometer reading in a separate location making tampering more difficult/costly. • Vehicle registration records will have annual odometer reading history; odometer cannot be turned back further than last reading. • Flagging/investigation of suspicious cars. • High fines. • Criminal prosecution for theft/fraud.
Stopped odometer (amateur theft)	• Failed odometer (breakdown). • Stopped odometer.	• Speed/tach/odometers will not operate. • Many new the vehicles will not run when odometer detached. • Tampering voids insurance. • Risk of fines and criminal prosecution.	• LOW-MEDIUM: rate multiplied by every km not recorded (e.g., 10,000 kms not recorded at $0.04/km equals $400) • Benefit is highest for high risk drivers in high rated territories • A disconnected odometer could be detected during crash investigations, so no insurance would be "stolen" (it would be voided) and incentives for disconnection would be low.	• Policyholder must inform insurers immediately of a stopped odometer else insurance is invalid; insurers provide temporary coverage and time limit for repairs. • Odometer is inspected at repair • Registration records will have annual odometer reading history • Inspection of odometer can reveal most induced stoppages. • Sharp deviations in patterns from previous driving history spark investigation.
Falsifying, altering, reassigning or laundering titles	• Titles tampered with by dealers, owners or auctioneers to show fewer miles.	• Cost of professional calligrapher or artist. • Time spent doctoring documents. • Risk of fines and criminal prosecution.	• NONE: this type of tampering is only useful for raising the value of a car for resale. • Since title frauds only affect the ownership transfer of a vehicle, it cannot assist with the theft of insurance.	• None required to prevent insurance fraud, however accurate audits of odometers can help prevent title frauds by providing a central database history of odometer readings for any car in BC; title frauds would be virtually impossible as verification would be easy.

[64] Les Shufelt, repair supervisor with United Automotive Distributors in Burnaby which specialized in General Motors odometer repairs, interviewed August 1998, indicates that odometer rollback can almost always be detected with gear-driven odometers as the plastic retainer that holds the odometer wheels cracks once opened and digits are usually misaligned. Digital odometers are virtually impossible to rollback. The ROM (read-only memory) chips that record mileage are proprietary. Fraud would require the manufacture of new ROM chips and the personalized recording of a mileage greater than the last audit. A new instrument panel bearing a lower mileage could also be obtained from a scrap yard, however the newer instrument panel would have to be an exact model match with a mileage greater than the last audit. Furthermore, the removal and installation of instrument panels would require the breaking seals. The instrument would also cost $300 and installation would require at least 2 hours of labour.

Even if as many as 2-4% of vehicle owners altered their odometers to disguise half their true miles driven each year, only 1-2% of insurance charges would be "stolen," a theft rate comparable to other consumer goods. Fraud rates are likely to be far lower than with current insurance pricing, which is based on self-reported estimates of annual mileage or commute distance, and other factors that are seldom verified and which have minimal penalties.

Annual odometer audits would provide an odometer reading history that could virtually eliminate used vehicle sale mileage fraud. The Automobile Retailers Association Used Car Division has asked that odometer readings be collected during vehicle registrations as a way to provide a reliable mileage record in order to discourage odometer tampering.[65]

Auditing Inaccuracies.
Odometer auditors may occasionally make honest mistakes or could accept bribes to underreport true mileage readings. Both problems are likely to be small. Honest mistakes should be no more common than mistakes by meter readers. Minor misreporting that occurs one year would be corrected the following year, and major misreporting could be caught by computers (programmed to identify negative and unreasonably large readings) or by vehicle owners when they are asked to overpay. Intentional underreporting could be identified by undercover investigations, and would also be corrected the first year that the vehicle owner failed to bribe an auditor.

Table A-14 **Types of Odometer Reading Error At AirCare Inspections**[66]

Error Source	Problem	Mitigative Measures
Communication errors	Inspectors currently ask vehicle drivers to report their odometer readings. Communication errors can result in the inspector input incorrect values.	Accurate visual inspection auditor can eliminate these transmission errors. Mileage readings can be checked against the mileage history for that vehicle for consistency.
Rounding	Currently, inspectors input odometer data in multiples of 1,000.	Odometer readings can be recorded to the nearest kilometre or mile.
Odometer reset to zero	Older odometers only have five digits and so reset to zero after 99,999. If the vehicle had a high odometer reading (e.g., 80,000 km) and is driven more than 100,000 km in a year, the 100,000 km would be underreported.	There are very few of these older vehicles (usually at least pre-1985, earlier for Japanese vehicles) currently in the vehicle fleet.[67] Very few private vehicles travel over 100,000 km/year, particularly older vehicles.
Odometer misread by factor of 10	Some odometers have a 0.1 digit. An inexperienced inspector can mistake this as a 1 digit, thereby inflating the odometer reading by tenfold (e.g., a reading of 34,563.4 read as 345,634).	Trained inspectors can easily recognize 0.1 digits (which are usually coloured differently than other digits). Such mistake would be easily spotted by computers and policyholders, since it would produce extremely high readings.
Miles-based odometers	Pre-1978 vehicles, and vehicle imported from other jurisdictions may have mileage-based odometers.	Train inspectors to identify odometers as being miles- or kilometre-based.

[65] Ed Hendricks, President, "Odometer Readings," Automobile Retailers Association, Used Car Division, letter sent to Insurance Corportion off British Columbia, 11 June 1997.
[66] S.J. Stewart, *A Study of Mileage Accumulation Rates of Light-Duty Vehicles in the Lower Fraser Valley*. Warrendale, PA: Society of Automotive Engineers (SAE), 1995. SAE Technical Paper, 961702.
[67] Shufelt, August 1998, indicates he not seen a five digit odometer in 9 years.

Additional benefits from regular odometer audits are summarized in Table A-15.

Table A-15 **Benefits of an Odometer Auditing System**

Type of benefit	Description	Prime Beneficiaries
Reduced odometer fraud	Odometer auditing reduces ability and incentives to tamper with odometers. Publicly available annual odometer records allow prospective purchaser to detect aberrant readings. This reduces losses and increases road safety.	Used vehicle purchasers, and dealers.
Lower insurance payouts due to over-inflation of car value	Insurers assesses the value of a car based in part on total vehicle mileage. Since odometer rollback effectively increases the value of a car, insurers overpay on claims that use odometer readings when valuing vehicles.	Insurers and policyholders.
Easy detection of phantom vehicles[68]	Having a centralized database of VINs, registration numbers and annual mileage recordings will help claims adjusters and SIU to easily identify suspect vehicles.	Insurers and policyholders.
Data for transport analysis	Annual odometer audits would provide comprehensive travel data.	Transportation researchers.
Data for actuarial analysis	Insurers would be able to improve their rating structure to take into account vehicle travel.	Insurers and policyholders.
Implementation of other distance-based fees	Once an odometer auditing system is established, it is easy to institute other mileage-based fees.	Society.

[68] "Phantom vehicles" are vehicles that are insured using fake registration numbers, but that do not actually exist. Criminals will register "phantom vehicles" and later report them to insurers and stolen

Appendix 5

Criticism of Distance-Based Insurance

This section examines concerns and criticism of distance-based insurance.

1. Mileage Rate Factor[69]

Concerns about applying a significant mileage rating factor include:

- Mileage actually has little impact on crash rates.
- Difficulty collecting accurate annual mileage data with out verification and enforcement.

Data described in this report indicate that the first concern is not technically valid, but the second concern appears to be legitimate unless mileage data is independently verified.

2. Pay-at-the-Pump[70]

Concerns about PATP include:

- It would be regressive, imposing higher costs on the poor and rural residents.
- It causes some groups of motorists to overpay and others to underpay their true insurance costs. Groups that would likely overpay include rural motorists, commercial vehicle users (such as businesses that use gasoline vehicles for deliveries), and motorists with fuel inefficient vehicles.
- It only converts a portion of total insurance premiums to distance-based pricing and requires additional surcharges on vehicle registrations and licensing.
- Many drivers could evade the surcharge by purchasing fuel in other jurisdictions or illegally.

There is some debate as to the technical validity of the first concern.[71] The other three concerns appear to be technically legitimate.

3. Per-Mile Premiums

Cardoso and Woll

Summary of comments published in the *Journal of Actuarial Practice*, Vol. 1, No. 1, 1993 by Ruy Cardoso and Richard Woll in response to Patrick Butler's article proposing Per-Mile Premiums.

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[69] Lyn Hundstad, Robert Bernstein, and Jerry Turem, *Impact Analysis of Weighting Auto Rating Factors to Comply with Proposition 103*, California Dept. of Insurance (Sacramento), 1994.
[70] 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; Rayola Dougher and Thomas Hogarty, *Paying for Automobile Insurance at the Pump: A Critical Review*, American Petroleum Institute (Washington DC), 1994.
[71] Jeff Allen, Roland Hwang and Jane Kelly, *An Equity Analysis of Pay-as-you-Drive Insurance in California*, Union of Concerned Scientists (Berkeley), 1994.

Cardoso's comments:

- Although perhaps justified theoretically, the fact that insurers don't usually use mileage as a rating factor except in the broadest categories must be proof that it is not practical, either because insurance customers don't want to have their odometers read, or because the administrative costs to insurance companies outweigh the benefits.
- Available empirical evidence does indicate that higher-mileage drivers tend to have more than average number of accident claims, but there is insufficient evidence to determine whether the correlation is perfectly proportional, so a fixed per-mile rate may not be appropriate.

Woll's comments:

- Other factors besides mileage also affect crash rates. Evidence from a 1991 study by the Allstate Insurance in California shows that lower-mileage vehicles have higher per-mile crash rates than high-mileage vehicles, and that other factors, such as territory and driving experience have equal or greater weight in explaining crash rates than annual mileage.

David Snyder

Comments by David F. Snyder, Assistant General Counsel of the American Insurance Association for *The Economic Policy Institute Conference on Clean Insurance, the Benefits of Mileage Based Auto Insurance Policies*, December 10, 1998.

The American Insurance Association represents more than 300 insurers that provide private passenger and commercial auto insurance in all 50 states, the District of Columbia and around the world. These companies have decades of experience in the market with millions of customers and with insurance regulation in every jurisdiction in which they do business.

I bring their perspectives, and my own as a former assistant to an insurance regulator in a major state, as mayor of a small city in the Washington, D.C. metro area, board member of regional transportation planning agencies and an active member of a local rescue squad which handles a significant amount of motor vehicle crashes. I am not, however, an actuary.

Impartial Actuarial Review Of The Papers Presented Today Is Essential

The papers presented today should be forwarded to the American Academy of Actuaries for their review. This is critical because State rating laws incorporate expert actuarial principles into their standards for legally acceptable rates. As expert as many of us are in our respective fields, none but actuaries can provide the expert review needed for these papers to assure they are valid. Otherwise, it would be like physician assistances opining on the validity of papers on orthopedic surgery. I offer my assistance in obtaining for your this kind of essential review and commentary.

It is my view that some of the findings in the paper are wrong. The risk of having a claim, in my observation and experience, is much more related to who is driving (e.g. experienced versus inexperienced, law abiding versus aggressive or sober versus drunk) and the environment he or she is driving in (congested urban streets versus wide open interstates) than mileage. But as with the conclusions drawn in the papers, my views should be tested by credentialed actuaries using expert principles and standards.

In fact, the overwhelming weight of available actuarial opinion seems to be at odds with many of the findings included in the papers. See the attached exhibit [reproduced below] which illustrates that contrary to the papers, miles driven in reality explain very little of auto insurance risk compared to

territory or age of driver, for example. This kind of variance underscores the imperative of expert actuarial review.

Table A-16 **Percent of Risk Explained**[72]

	Bodily Injury	Property Damage Liability	Uninsured Motorist	Medical Payments	Collision	Compreh-ensive
Driver Record	5.6%	12.2%	2.2%	3.0%	2.9%	2.9%
Mileage	*8.1%*	*9.4%*	*12.3%*	*15.9%*	*17.2%*	*9.5%*
Years Licensed	25.6%	43.9%	19.2%	29.5%	13.5%	5.7%
Value and Age	8.9%	6.3%	8.6%	12.1%	58.3%	64.0%
Territory	49.7%	19.6%	54.3%	35.0%	5.9%	13.9%
Use	0.2%	1.0%	0.4%	0.2%	0.2%	0.0%
Milti-Car	1.8%	5.4%	0.5%	2.1%	0.5%	0.0%
Gender	0.9%	2.2%	2.4%	2.2%	1.5%	3.9%

Values Determined Based on Sequential Analysis Methodology

While Not A Complete List of Reforms, Most of the Goals Set Forth In The Papers are Commendable

From Baker and Barrett, the four goals for mileage based auto insurance policies would appear to be: reduce accidents, reduce congestion, reduce emission of greenhouse gases and create a more equitable system. Khazzoom lists the arguments in favor of Pay-at-the-Pump: efficiency, saving, coverage of currently uninsured drivers, safety, incorporation of transportation externalities, environmental benefits, and benefits for the balance of payments and US security. Edlin and Litman presumably predict fewer accidents, less congestion and reduced motor vehicle crash costs. All of these goals are worthy and can be achieved in many ways, in most cases more directly and effectively, by other than mileage based auto insurance.

Safety Advances Have Occurred and Can Best Be Pursued Outside of Mileage Based Insurance.

Accident and death rates are at historically low levels, despite historically high levels of miles driven. This suggests strongly that highway safety is not chiefly dependent on mileage. To the contrary, the evidence is that safer cars, better highways and improvements in some driving behavior have been the causes for the progress in safety. Specifically, this movement has occurred through safer motor vehicles (including airbags), increased safety belt use, better designed highways, increased focus on drunk driving and enforcement of anti-drunk driving laws and graduated licensing programs for young drivers.

Clearly, more needs to be done. Higher travel speeds are resulting in more than necessary fatalities, requiring better speed enforcement by way of technology such as photo radar and more police presence. Traffic signal running, and tailgating are wide spread and red light cameras and more enforcement are effective countermeasures. Additional legislative action on primary enforcement seatbelt laws, graduated licensing laws, and continued efforts on drunk driving will be important. However, there is little evidence that reducing miles driven will have significant independent impact on highway safety when compared to these other interventions.

Reducing Congestion Presumably Can Be Done By Any Device That Greatly Increases The Cost of Driving But There Are Many Negative Social And Economic Consequences

[72] *1989 California Actuarial Advisory Committee Study – Allstate data*, California Auto Rating Seminar, Sept. 24-25, 1998.

Much of the driving, particularly by workers, commuters and business people, such as sales and service personnel, is NOT discretionary and for many of them, there is not a useful and affordable alternative. Greatly increasing the costs of driving by mileage based insurance, a gas tax or any other device increases the costs of working and doing business, penalizes the most productive people in our society and discourages business and employment activity and expansion. None of these results are, in my view, good public policy.

There Are Other Ways To Improve Air Quality Without The Negative Social And Economic Dislocations And Consequences Of a Gas Or Insurance Tax On Driving.
Voluntary approaches and incentives are more the order of the day on environmental issues in general than government edict, whether in the form of regulatory control or punitive gas taxes, whether overtly applied or covertly applied through mileage based auto insurance. In addition, technological improvements such as low and zero emission vehicles and attractive alternatives to the single occupancy vehicle, including mass transit, offer better ways to improve air quality while not triggering the negative social and economic consequences inherent in dramatically and artificially increasing the cost of driving.

Mandatory Mileage Based Auto Insurance Is Less Fair and Equitable Than Today's System.
Auto insurance rating systems are tested in the market every day, subject to review by insurance regulators, and verified by the experience of millions of customers and claimants. They are risk based, accurate, actuarially sound, unbiased by arbitrary assumptions and therefore are fair and equitable. A mandated departure from the current auto insurance rating programs by imposing unwarranted mileage based rating systems will result in cost shifting and better drivers paying more while worse risk drivers pay less.

Future Cooperation and Success Depends On Addressing The Fundamental Issues First.
The real inequities in most State auto insurance systems are not even addressed by mileage based liability insurance. Under tort liability systems, many injured victims receive no compensation. The few who do must often wait years for any recovery and when they finally receive compensation, it is reduced by 1/3 or more for litigation related expenses, including legal fees. Further, the liability based auto insurance systems encourage and reward fraudulent behavior and abuse of the health care system and result in much higher than necessary costs to all payers, including government health programs and insurance consumers.

Yet these equity problems are ignored? Why? We urge the proponents of mileage based insurance, if serious about equity issues, to work with us to address these issues to bring about a more equitable system and reduce over all costs, goals we all share. When the basic product is improved for consumers by solving these problems or allowing them more choice, then we can appropriately review if and how the allocation of the remaining costs can be improved, without negative social and economic consequences. And part of this latter effort must include both impartial expert actuarial analysis and a thoughtful review of the practicality and expenses of changing over to alternative systems, which I think are understated.

DISCUSSION AND EVALUATION OF CONCERNS

Insurance pricing already incorporates mileage.
Although some insurance companies incorporate mileage factors in their pricing, such as commute distance or estimated annual mileage, none begins to approach actuarially accurate, marginal pricing. Current mileage weighting factors would need to increase by an order of magnitude to be actuarially accurate.

Mileage is less important in predicting crashes than other rating factors.
This could be legitimate criticism for Pay-at-the-Pump insurance but is irrelevant for distance-based pricing options that incorporate existing rating factors. Whether mileage is more or less significant than other rating factors is unimportant if each factor is included in the rate structure.

Until recently insurance companies had no reliable source of mileage data and so could not accurately calculate the relationship between mileage and claims. Evidence used by the insurance industry to argue that mileage is not a significant rating factor is technically flawed. More recent data based on independent odometer readings shows a strong relationship between mileage and claims within existing price categories.

Travel foregone could be lower risk than average, so premium revenue could decline more than claim costs.
This concern is technically valid but there is no evidence that it is true. Available evidence indicates that broad vehicle travel reductions result in proportionally *greater* reductions in crashes and claim costs. A pilot project to test the effects of distance-based pricing could address this concern.

Distance-based insurance unfairly increases costs to high-mileage drivers (rural drivers, long-distance commuters, business drivers, etc.)?
Distance-based pricing would increase costs for motorists who drive significantly more than the current average *within their price group*. It would not increase costs for rural motorists as a group, only for rural motorists who drive significantly more average rural motorists. If motorists reduce their mileage as predicted, most would save money and experience net welfare gains. Few motorists should experience more than a few percentage increase in total vehicle costs. Those who pay more would tend to receive the greatest benefits from reduced congestion and increased road safety.

Evidence described in this report suggests that distance-based vehicle insurance is relatively progressive and benefits lower-income motorists overall. Any price increase occurs because higher-mileage drivers are currently being subsidized at the expense of lower-mileage motorists in their price group. Since vehicle use tends to increase with income these subsidies are regressive. This suggests that any price increase that does occur increases equity.

People need their cars too much to give them up. There will be no reduction in travel.
Distance-based insurance is not expected to cause people to give up cars. In fact, because it reduces fixed costs, vehicle ownership is likely to increase slightly. There is extensive evidence that vehicle travel is affected by vehicle operating costs. A modest reduction in total annual mileage is predicted, based on standard price elasticity values.

Automobile insurance reform should focus on equity, affordability and safety.
Distance-based pricing can be an effective way to achieve all of these goals. It increases equity by making premiums more actuarially accurate, and reducing costs for lower income

motorists. It allows motorists to save money and makes automobile ownership more affordable. It can significantly reduce traffic crashes, and provides accurate crash rate information that can improve the effectiveness of road safety programs.

Consumers will not accept this change.
The Progressive Insurance Autograph pilot project, and market surveys indicate consumer demand for distance-based pricing. The National Motorists Association (a motorist advocacy organization) supports per-mile insurance. Support is likely to increase as consumers learn more about its benefits, particularly if it is a consumer option.

Safety advances/congestion reduction/air pollution reduction/energy conservation can best be pursued in ways other than mileage-based insurance.
It is unnecessary to choose *between* distance-based insurance and other strategies. Distance-based pricing can increase the effectiveness of these other strategies. Because of its multiple benefits, distance-based insurance can be one of the most cost-effective ways to achieve these objectives.

Odometer fraud will be a major problem.
Although some odometer fraud may occur, it is expected to be a minor problem overall, with fraud rates comparable to other common consumer transactions, and far lower than with current insurance pricing. Regular odometer auditing should discourage and identify most tampering, odometers are increasingly tamper resistant, and the financial incentive for fraud is relatively low. Insurers financial exposure would be minimal since odometer fraud can often be identified during accident investigations, which would void coverage. This concern can be addressed through additional research and program design.

It would increase administrative costs to insurers and inconvenience vehicle owners.
Odometer audits should be significantly cheaper than AirCare inspections because they require less equipment and specialized training, can be performed in conjunction with other vehicle servicing, and can be provided by a large number of businesses in a competitive market. Total incremental costs are modest (predicted to be about $7.50 per vehicle year), and far smaller than direct benefits to consumers and society. Even if odometer audits cost as much as AirCare inspections, benefits still exceed costs many fold. Further research and sensitivity analysis can help address this concern.

If distance-based pricing were better, insurance companies would already use it.
Although distance-based insurance pricing offers many benefits, there are several barriers to implementation by an individual insurer. Most financial savings are passed back to customers, and much of the insurance cost savings accrue to competitors. Only minor portions of total benefits accrue to a company that offers distance-based pricing. Insurance companies do not profit from reductions in uncompensated crash costs, congestion, infrastructure costs, or pollution, nor do they benefit directly from increased equity. One study estimates that

individual insurers would only save a third of total crash cost savings, and about an eighth of total benefits.[73]

Insurance companies currently maximize their profits by maximizing their gross revenue, since profits are dependent on investment income. A pricing strategy that reduces crashes would reduce profits if regulators or market competition required a comparable reduction in premiums.

An individual company would have relatively high administration costs to establish an odometer auditing system. Although there are potential financial and marketing benefits, these longer-term saving which would have to offset an individual insurer's short-term revenue losses and risks. It is therefore not surprising that insurers have not tried this price structure.

This type of pricing has never been used before.
Some vehicle insurance is already distance-based: rates for fleets and commercial vehicle coverage are often based on mileage, and the Progressive Insurance company currently offers GPS-based pricing. There is nothing unique about pricing a good based on some measure of consumption. Vehicle insurance is unusual among major consumer goods for having pricing that allows unlimited consumption. Electricity, fuel and food are not usually sold with a fixed price that allowed virtually unlimited consumption.

Odometer auditing would be an invasion of privacy.
Odometer readings are already collected on vehicle sales, during emission inspections, and vehicle servicing, and as part of crash investigations. These odometer readings are even sold by private companies to used vehicle purchasers who want to validate mileage information. Odometer auditing simply standardizes the collection of this information. Odometer auditing does not identify when or where a vehicle has been driven, or provide any other information that could be considered private. Odometer auditing would provide consumer benefits, including verified information on every vehicle's mileage history.

[73] Edlin, op. cit.

Table A-17 summarizes these concerns, discusses their legitimacy and potential responses.

Table A-17 **Summary of Concerns**

Concern	Legitimacy	Possible Responses
Data showing correlation between mileage and crashes is inaccurate or unrepresentative.	All available evidence indicates that reductions in mileage tend to reduce crashes.	Further research and pilot studies.
Reduced vehicle travel will provide less than predicted insurance cost savings.	Available evidence indicates that broad vehicle travel reductions result in proportionally *greater* crash reductions and insurance cost savings.	Further research and pilot studies. Prices should initially be set relatively high to provide adequate revenue.
Distance-based insurance is less fair and equitable than current pricing.	Distance-based pricing is most actuarially accurate, and therefore fairer than current pricing. It also tends to benefit lower-income households.	Explain equity benefits of distance-based pricing. Make participation optional.
It would be unfair to high-mileage groups, such as rural residents, businesses, and long-distance commuters.	Distance-based pricing would increase costs for motorists driving significantly more than average *within their group*, but costs would not increase for price groups as a whole. Most motorists in all groups would save overall.	Explain equity benefits of distance-based pricing. Make participation optional.
Motorists will not respond to the price incentive. There will be little vehicle travel reduction.	There is extensive evidence that motorists respond to price incentives. Progressive's Autograph program participants reduced their mileage an average of more than 13%.	Additional research, pilot studies and sensitivity analysis.
Estimates of benefits are overstated. True benefits will be significantly smaller than predicted.	Standard models are used to predict benefits Virtually any reasonable estimate indicates that per-kilometre pricing provides net economic benefits.	Additional research, pilot studies and sensitivity analysis.
Distance-based pricing increases consumer cost, making them worse off.	Increased variable costs are offset by reduced fixed costs. Most motorists would save overall. Reduced mileage represents low value travel that consumers willingly forego to save money.	Illustrate why most consumers would be better off overall. Make participation optional.
There are other ways to reduce crashes, congestion, pollution, etc.	Although there are other ways to achieve these objectives, they are all enhanced if implemented with distance-based insurance.	Show how distance-based insurance can help achieve various objectives.
Incremental costs may be higher than predicted.	Even if administrative costs are much higher than predicted, benefits would significantly exceed incremental costs.	Further research into costs, and pilot studies.
Odometer fraud will be excessive.	Odometer fraud should be a modest problem. Mileage data is comparable in accuracy to data used for other commercial transactions.	Research into odometer fraud and strategies to prevent it.
Odometer auditing is an invasion of privacy.	Annual odometer readings provide no information on when and where a motorist travels. Mileage data is already collected by businesses and governments.	Explain odometer auditing. Regulate access to the data. Make participation optional.
If distance-based insurance were better, it would already be used.	Most benefits of distance-based insurance accrue to consumers and society in general. Individual insurance companies have had little incentive to implement it on their own.	Further research and pilot studies to investigate the feasibility and benefits of distance-based insurance.

Appendix 6
Press Coverage Related to Distance-Based Insurance

"Paying for Car Insurance by the Mile" Anne Eisenberg, *New York Times*, April 19, 2000.

Electricity bills depend on how much electricity is used each month. Soon auto insurance premiums, too, may be metered, based partly on how much the car is driven.

That is the goal of Progressive Auto Insurance, which is testing a system that uses Global Positioning Satellite technology to track when, where and how much its auto insurance customers drive - and then charges them accordingly. A pilot version of the program is being tested in Texas.

The system is the brainchild of Robert J. McMillan, a business development leader at Progressive, a major auto insurance company based in Mayfield Village, Ohio. "It's very simple," Mr. McMillan said. "The less you drive, the less you pay."

Mr. McMillan came up with the idea of metered car insurance five years ago when he found out that G.P.S. technology could be used to recover stolen cars. "It occurred to me that we could record driving behavior and patterns and then offer insurance by the mile," he said. The company has been awarded two patents for the way it electronically retrieves data from vehicles and uses that information to set insurance rates.

About 1,100 people in Texas have signed up for a test run of the program since it began 18 months ago. One of them is Gus Kopriva of Houston, who owns four cars. "I'm saving a lot of money," he said. "I use some of the cars intermittently, and when I do, I pay."

The average user saves about 25 percent, Mr. McMillan said. "When people live close to work or have multiple vehicles, car-pool or use public transportation, they can save even more," he said.

The time of day affects the cost. "A mile driven at 2 a.m. is four or five times more expensive than one driven at 7 a.m.," Mr. McMillan said. "Our data show accident rates per mile are much higher later in the night." Commuting trips to work are cheapest because the trips occur on familiar routes in relatively slow traffic.

Mr. McMillan said even customers who drove long distances could save money on their current rates by avoiding nighttime driving.

The proprietary system used by Progressive includes a G.P.S. receiver, cell-phone modem and a microprocessor with a small amount of computer memory. The miniprocessor uses the G.P.S. receiver to record the car's location --latitude and longitude -- and the date and time every six minutes while the car is being driven. Once a month the company computer calls the car through the cell-phone modem and retrieves the records of the month's travel activity.

"Then we generate a bill that is similar to a utility bill, based on your use, "Mr. McMillan said.

Twenty-five percent of the fee represents standard insurance charges for damage and theft coverage -- taking into account factors like age, number of moving violations, the driver's sex and the type of car -- and the remainder is based on use.

"Traditionally, rates are based on variables like gender and age," he said. "We think how you actually use your car is more relevant."

The system cannot fix a flat yet, but it can unlock a locked car; car owners who are locked out can place a call to the monitoring center, which relays a command to the microprocessor through the modem to tell it to open the doors. And if battery power runs low, the microprocessor can use the modem to notify the company's central computer so an employee can call the car's owner. The system can also provide more standard G.P.S. services like navigation, as well as a panic button linked to a 24-hour communication system with a live person to handle emergencies.

The tradeoff for all that convenience and potentially lower insurance costs is privacy, some say. After all, the system knows when you are sleeping and when you are awake. It also knows when a driver has been good or not, at least in terms of speeding, and perhaps in other areas as well.

"I'm not bothered by the lack of privacy," Mr. Kopriva said. "That only bothers people with something to hide -- for instance, if they are having an affair or running drugs." Mr. Kopriva said he was glad that the system kept track of his cars for him. "That would come in very handy if one of them was stolen," he said.

While Mr. Kopriva dismissed privacy issues, Steven Goldstein, a spokesman for the Insurance Information Institute, a trade group, predicted that some customers would not want an insurance company to have specific information about their driving habits.

"Some people will find it invasive," he said. "But others will be thrilled to death because they will save money."

Americans pay about $125 billion each year in premiums for auto insurance. "You can't drive your car without it," Mr. Goldstein said. "And most Americans do have a car -- except for those under 21, in jail or living in New York

City." He said the new program was noteworthy because it gave this huge pool of involuntary shoppers more options. "The more choices drivers have, the better off they will be as consumers," he said.

Progressive guarantees that the information gathered by the system will be used only to assess insurance rates and will not be provided to anyone else without the insured person's consent, Mr. McMillan said.

Still, the specificity of the details recorded is bound to raise thorny problems. For instance, the system will know whether the car stopped at a bar or was near the scene of a crime. And such information could be subpoenaed.

Progressive is talking to state insurance commissions about expanding the program beyond the test market. The company is also talking with auto makers about incorporating the system into cars at the factory. At present, Progressive pays the $500 cost of installing the system on each customer's car.

If drivers using the new system drive less, that will help the environment. Allen Greenberg, a policy analyst at the Environmental Protection Agency in Washington, said initial studies done by the agency suggested that the amount of driving people did was related to fuel price. He added: "We anticipate anywhere from a 10 to 20 percent driving reduction when the fixed cost of driving is shifted to a variable one. "The environmental potential here is very great. The program offers financial incentives to drive less and therefore reduce pollutants and improve air quality."

Motorists Could Drive Down Costs Of Insurance; As Lawmakers Advance A Bill That Would Tie Rates To Miles Driven, Some Say The Program Could Cut Traffic Congestion And Pollution

The Oregonian, Saturday, May 5, 2001, Page A1, By Tomoko Hosaka

SALEM -- Drive less. Save money. It's a simple concept that one day could change how motorists pay for car insurance.

Supporters, who say such plans can reduce premiums, control congestion and cut pollution, hope lawmakers will help jump-start the idea in Oregon. House Bill 3871 would give companies tax breaks for offering voluntary mileage-based insurance policies.

"To me, it makes sense to try to give people a financial incentive to drive less," said Rep. Charlie Ringo, D-Beaverton, one of the bill's sponsors. "Right now, one of the only direct financial incentives is what you pay for gas. You drive more, you pay more."

The House Transportation Committee unanimously approved the bill Friday and sent it to the House revenue committee. At Friday's hearing, consumer, insurance and environmental groups praised the proposal as an innovative idea worth advancing.

But they also acknowledge that legislators, increasingly under time and money constraints, probably are not ready to embrace the idea this session. HB3871 would reduce state revenue, although state economists have not determined by how much. And because the concept remains in its infancy nationwide, the insurance industry is unsure how soon it could develop and implement an effective, cost-efficient program.

Currently, car insurance rates are calculated by a driver's average risk, determined by factors such as age, sex, driving record and vehicle type. Most policies also take into account some mileage, such as the average length of commute. The idea of insurance rates based primarily on the use of a car is to give drivers control over premium costs, rewarding those who spend less time on the road.

Miles or time driven could be tracked through regular odometer readings or by installing high-tech devices, such as satellite global positioning systems.

"Insurance has conventionally not been able to pool all of the risk factors that are really related to whether you're going to be in an accident," said Chris Hagerbaumer, air and transportation program director for the Oregon Environmental Council. "And miles driven is strongly correlated."

Environmental groups such as the OEC are keen on the idea, which they say would extend beyond consumer savings. Fewer cars also means less traffic, fewer accidents, less pollution and less wear and tear on roads.

Studies suggest that mileage- and time-based plans can reduce driving by 10 percent to 20 percent, said Allen Greenberg of the Federal Highway Administration, which is studying the potential benefits of such plans.

The only insurance company that has tried the idea is Ohio-based Progressive Insurance Co., the state's fifth-largest auto insurance firm with about 57,000 Oregon policyholders. In August 1998, Progressive began a pilot program in Houston to test an in-vehicle electronic system that tracked driver mileage, time of day and general driving-area information. It expanded the test to all of Texas a year later.

The company is evaluating the results to decide whether to expand the program, spokeswoman Courtney Neville said. Offering a mileage-based policy did not reduce company costs, she said, but would not reveal further financial details. The program saved participants about 25 percent compared with traditional plans in Houston, she said.

Brian Boe, a lobbyist for the National Association of Independent Insurers, said his group supports the bill. In a competitive car insurance market such as Oregon, offering companies incentives to provide innovative products is good for consumers, he said.

Whether the idea catches on will depend on the evolution of technology, Boe said. Insurance companies say it's still unproven and too expensive for them to offer. And lobbyist Jack Munro, who represents the American Insurance Association, says electronic tracking raises privacy concerns that could affect the future of mileage-based insurance.

Even if the bill falls short this session, supporters say they are encouraged by the committee's unanimous approval. There could be opportunities to pursue the idea outside the Legislature, Hagerbaumer said, such as Progressive's pilot program, which was conducted in conjunction with several federal agencies.

"We're in the initial stages, but interest is peaking," she said. "We're definitely going to push it to other venues. There's a lot of enthusiasm out there from drivers."

Some Want Car Insurance Rates Based On Mileage

Seattle Post-Intelligencer
Publication Date: Dec, 17, 1998

Imagine negotiating your annual car-insurance premium based on how far you drive. How about paying for auto insurance at the gas pump?

Neither is an idea whose time has arrived, anywhere in the country. But a group of "green-tax" advocates hope that if Washington could be the first to use concrete floating highway bridges it can become the first to require paying for insurance based on how much people drive.

The idea, originally floated several years ago, found its way back into state politics last week in a report called "Road Relief," compiled by the Olympia-based Energy Outreach Center, a nonprofit group that researches energy and land-use issues.

The report contains several proposals aimed at taxing some of the hidden costs of driving, making driving expensive enough so that some will quit. But it was the insurance proposals that got most of the attention at a seminar last week in Seattle.

Victoria (B.C.) Transport Policy Institute analyst Todd Litman, one of the authors of the report, said motorists who drive less than 12,500 miles annually "are subsidizing the insurance cost of high-mileage drivers," those who log more than 15,000 miles a year.

That is because insurance policies recognize few distinctions between high-mileage and low-mileage drivers, though some policies give discounts to drivers who don't use cars for commuting to work.

Basing insurance rates on miles driven would remove that inequity, he said. Annual charges would be based in the normal way, on the driver's age, record and the type of car driven, but dividing the total by the annual miles driven would establish a per-mile rate.

Drivers who drove the least would pay the least. Each could be given a rebate or a credit on each following year's bill if they drove fewer miles than expected; drivers who exceeded their estimate would pay more. Litman said it would be a relatively simple matter to set up a certified odometer checking system, perhaps at local service stations, with yearly checks costing $7.50 and numbers made available to insurance companies for verification.

He estimated this would save an average motorist $75 per year on a $700 annual car policy, cut driving 10 percent overall and cut congestion time 20 percent. It also would benefit insurance companies, he said, by reducing the number of accidents as miles driven declined.

Litman liked per-mile pricing better than the idea of paying for insurance at the pump, per gallon - an idea floated several years back in a book by financial writer Andrew Tobias.

In Pay-at-the-Pump insurance, the cost of premiums is added to the price of each gallon of gasoline, perhaps at the rate of 30 to 40 cents per gallon, so that drivers pay their premium off in installments, with each fuel purchase.

Litman doesn't care for the Pay-at-the-Pump concept, because a flat price per gallon doesn't reflect the higher-cost risk of insuring a bad driver and because the price generally only pays for liability coverage, not the theft or collision insurance many drivers opt for in addition to coverage for injury or property damage.

But some people attending the two-day conference on the Outreach Center's report think the Pay-at-the-Pump approach might be a better idea. One was Seattle City Councilman Richard Conlin, who said paying insurance in the price of fuel would more quickly discourage motorists from excessive driving.

"The more gas you use, the higher the cost," Conlin said. And per- mile charges might encourage more odometer tampering, even on modern cars with electronic systems.

Conlin thinks the Legislature isn't ready yet for considering either proposal but may be after the next session, when much of its time will be spent on dividing up $2.4 billion in highway-referendum money approved by voters in last month's election.

Others think the underlying assumptions - that alternate insurance-funding methods can cut

driving, fuel consumption, congestion and pollution - still need testing.

Jim Stevenson, spokesman for the state insurance commissioner's office, said the insurance industry, conservative and wielding great political clout, would be wary of the fundamental changes such proposals require.

Jon Torgerson, director of an industry trade group in Seattle, said most insurance companies already offer discounts to policy- holders who commute by bus or carpool. He said the center's proposals don't offer drivers enough additional incentives to stop driving.

And paying per gallon at the pump could result in all drivers paying the same amount without taking into account the differences in driving records and risk, he said.

Litman conceded, during last week's conference, that one problem is that per-mile insurance would reduce costs not only for the companies offering the program but for their competitors as well, by reducing accident risks to drivers insured by all companies.

And rural motorists, often forced to drive greater distances to work or shopping, may balk at paying by the mile.

State Sen. Jim Horn, R-Mercer Island, a member of the Senate Transportation Committee, said the legislature would likely be reluctant to adopt the proposals because they'd penalize Americans for driving, one of the freedoms they enjoy.

Arizona News, March 2001
Last week this column was devoted to an editorial about how the state is "chip, chip, chipping away at our liberty." The editorial addressed the Legislature's efforts to expand police powers to stop and cite vehicle drivers and passengers simply for not using their seat belts, a move we believe to be an unwarranted intrusion on the personal rights of individuals.

This week we report that there's more bad news on the "chip, chip, chipping" front. The Maricopa Association of Governments recently released its Technology Outlook, in which some of our elected officials wistfully examined some of the technology that will be at their fingertips in the not-so-distant future. One little gadget that especially impressed them was the Global Positioning System, the tracking technology that now comes on some high-end automobiles.

MAG found out that Progressive Insurance is testing a GPS system to track the vehicle usage of its customers to make sure that each customer's insurance premium reflects his actual level of vehicle usage. Remember when you were filling out your auto insurance forms and the company asked you to estimate how many miles you drive in a week? Well, now they'll know exactly how many miles you drive every week (and where and when you go, by the way), and adjust your insurance rates accordingly.

MAG thinks that's a great idea, but your elected officials would like to take the concept one step further. They want to know exactly how many miles you drive every year on state roads so they can tax you accordingly. The more you drive, the higher your highway "user fees." As MAG puts it, "Congestion pricing may be the method to moderate travel and change travel behavior." No kidding. Why not just set up checkpoints every few miles where guards could demand, "Vhere are you goink! Are your papers in order? Ve are vatching you at all times!" German and/or Russian accents would be a job requirement for the guards, of course.

Or better yet, voters could demand that elected officials and high-level bureaucrats should be required to wear tracking collars around their neck. The collars could come equipped not only with GPS technology so we know which exotic dance bar they're visiting at the moment, but they could also carry miniature video cameras and microphones so we can know which lobbyists they talk to and exactly what promises they make to special interest groups that will ultimately sell their constituents down the river. Officials who violate the public's trust could be tracked down by employees of the Game and Fish Department, shot with tranquilizer darts, weighed, tagged and relocated to another state.

It's difficult to believe that educated, thinking individuals could actually believe that making life easier for government and corporate bureaucrats should be given priority over the privacy and liberty of individual American citizens. But then again, this is Arizona.

Other Press Coverage of Distance-Based Vehicle Insurance:

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.