Victoria Transport Policy Institute
"Efficiency · Equity · Clarity" www.vtpi.org
Telephone: 250-360-1560 | email: Info@vtpi.org

Pay-As-You-Drive Insurance

Recommendations for Implementation

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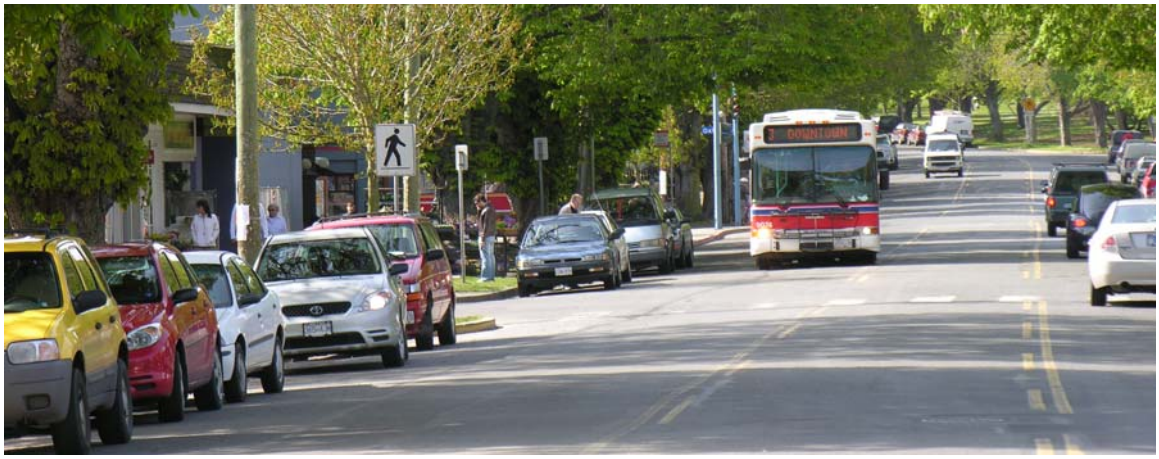
By Todd Litman
Victoria Transport Policy Institute



Vehicles are safest when parked. PAYD encourages motorists to reduce their driving, providing many benefits.

Abstract

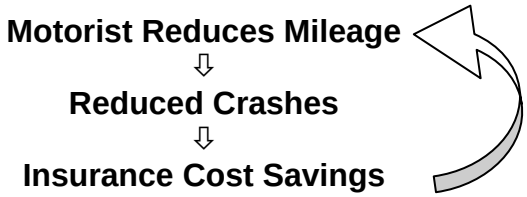
This paper provides guidance for implementing Pay-As-You-Drive (PAYD) vehicle insurance, which directly incorporates mileage as a rate factor. It describes PAYD pricing options, discusses PAYD benefits and costs, describes regulatory reforms, evaluates various objections to PAYD, and provides specific recommendations for PAYD implementation. Various data sources indicate that crash costs increase with annual vehicle mileage. As a result, PAYD increases actuarial accuracy (premiums better reflect a vehicle's claim costs). PAYD pricing rewards motorists when they reduce their mileage, providing financial savings and additional benefits including increased safety, congestion reduction, road and parking facility cost savings, energy conservation, emission reductions, and increased insurance affordability.

Although there are several possible ways to implement PAYD insurance, some provide more benefits than others. Insurance regulators can maximize benefits by defining performance standards that policies must meet to be considered PAYD, as described in this paper. Critics raise various objections to PAYD pricing, but many of these are technically inaccurate or can be addressed with appropriate implementation practices.

Introduction

Pay-As-You-Drive (*PAYD*, also called *Distance-based*) means that vehicle fees are directly based on the number of miles a vehicle is driven during a given period.[1] The California Department of Insurance is investigating ways to implement PAYD vehicle insurance in order to achieve insurance regulatory objectives and various planning objectives, including increased affordability, consumer savings, increased traffic safety and emission reductions (CDI, 2008). This paper explores PAYD insurance impacts and requirements, and provides recommendations for implementing it in California.

PAYD insurance reflects the principle that prices should reflect costs, and consumers who reduce costs should receive resulting savings. Reduced driving reduces crash risk and insurance claims. With current pricing, claim cost savings that result when motorists reduce mileage are retained as profits by insurers or returned to premium payers as a group. PAYD pricing return these savings to individual motorists who reduce mileage.



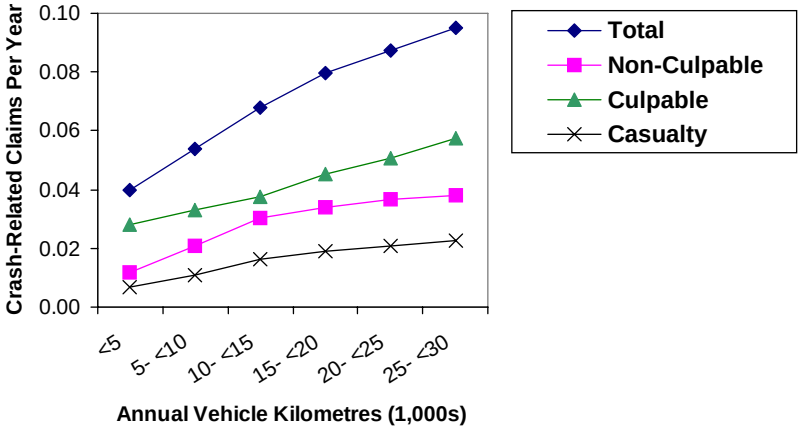
PAYD pricing returns to individual motorists the insurance cost savings that result when they drive less. It rewards motorists for reducing mileage and makes premiums more accurately reflect the insurance costs of each individual vehicle.

PAYD pricing gives motorists a new opportunity to save money, providing an incentive to reduce mileage, allowing individual consumers decide which miles, if any to forego. Any vehicle-miles reduced consist of lower-value vehicle travel that motorists willingly give up in exchange for savings, increasing their consumer surplus. To the degree that motorists reduce mileage, and therefore crashes and insurance claims, the savings that result are net benefits to society, not just economic transfers.

Until recently insurers lacked reliable mileage data and so they tended to underestimate the effects of mileage on crashes and insurance claims. New data (such as mileage data collected during vehicle emission inspections matched to insurance claim records of individual vehicles) show a strong positive relationship between mileage and crashes, as illustrated in Figure 1.[2] Even comprehensive claims (theft, vandalism and weather damage) are found to increase with annual mileage, apparently because such risks are greater away from home (Litman (2001).

[1] For more detailed descriptions of PAYD see Butler (1992); Litman (1997 and 2001); Edlin (1999); Harrington and Parry (2005); and Bordoff and Noel (2008).
[2] For detailed information on the relationships between mileage and crash rates see Litman (2001); Edlin and Mandic (2001); Litman and Fitzroy (2005); and Bordoff and Noel (2008).

Figure 1 **Crash Rates by Annual Vehicle Mileage** (Litman, 2001)



Annual insurance claims tend to increase with annual vehicle travel.

There are confounding factors that affect mileage and crash rates. For example, young and old drivers, people with disabilities, and urban residents who do more driving on surface streets, tend to drive lower annual mileage and have higher per-mile crash rates.[3] However, these factors can be incorporated into rating, either directly or by surrogates such as driving experience. Once these are taken into account (that is, for a given rate class) there is a strong positive relationship between mileage and crashes.

The relationship between mileage and claims is probably even stronger than Figure 1 indicates due to differences between mileage and claims within these large mileage classes, and other confounding risk factors that cannot be perceived until mileage is directly applied as a rating factor (Litman, 2001). For example, within the 5,000-10,000 annual mileage range for a particular rate class, motorists who drive 9,000-10,000 may be fitter and drive proportionately more miles on grade-separated highways than those who only drive 5,000-6,000. Once actuaries have experience with PAYD pricing they will have better data for calculating more accurate PAYD rates.

Available data suggest that a change in overall average vehicle travel (that is, travel that includes an equal mix of high- and low-risk vehicle-miles) provides about proportional change in claim costs borne by those vehicle's insurers, and proportionally larger reductions in *total* crash costs since about 70% of crashes involve multiple vehicles and the average crash results in about 1.5 claims (Vickrey, 1968; Edlin, 2003). As a result, each vehicle removed from traffic reduces both its chances of causing a crash and of being the target of a crash caused by another vehicle, and each avoided multi-vehicle crash reduces multiple claims.

[3] Urban miles tend to have relatively high per-mile crash rates but low fatality rates.

Benefits and Costs

PAYD can provide the following benefits (Litman, 1997; Funderberg, Grant & Coe, 2003; Bordoff and Noel, 2008):

- Increased actuarial accuracy. It makes premiums more accurately reflect the insurance costs of an individual vehicle, which is fairer and more economically efficient.
- Increased consumer options and a new opportunity for motorist to save money. PAYD pricing can be optional, allowing individual motorists to choose the best price structure for their needs.
- Increased traffic safety (Perry, 2004). Higher risk motorists have a larger incentive to reduce mileage, and motorists who reduce their mileage reduce crash risk to themselves and others. If broadly applied, traffic crashes should decline proportionately more than mileage, so for example, a 10% mileage reduction reduces crashes 12-15% (Edlin and Mandic, 2006).
- It reduces traffic congestion, roadway and parking facility costs.
- It reduces energy consumption and pollution emissions (CCAP, 2005; Harrington and Parry, 2005). If applied to all vehicles it will achieve approximately a third of the Kyoto emission reduction targets for private vehicles.
- It encourages walking, cycling and public transit travel, and so helps achieve benefits including improved physical fitness and health, and increased transit fare revenues.
- It increases insurance affordability, reducing the financial burden on lower-income motorists (Litman, 2004). Since annual vehicle travel tends to increase with income, most lower-income motorists will save money.[4]
- By increasing affordability it should substantially reduce uninsured driving (Butler, 2000).
- It reduces the need to rely on cross-subsidies from low-mileage motorists to provide "affordable" coverage to higher-mileage motorists, increasing equity.

PAYD implementation can also impose some costs:

- It requires new rate structures, administrative procedures and rate plans. Insurers bear these costs when rate structures change, but PAYD could increase these costs more than average.
- Most PAYD systems increase transaction costs (administrative costs per policy). Incremental costs range from less than $10 per vehicle-year for odometer-based systems, to more than $150 per vehicle-year for pricing systems that track vehicle location.
- Until insurers gain experience with this rate structure there will be uncertainties about risks.
- It can make premiums less predictable. Motorists and insurers would not know total premiums until the end of the insurance term.
- If universally implemented it may increase premiums for some motorists (those who continue to drive high annual miles in their rate class), although most motorists should save money.

[4] The vast majority of low-income motorists would save with PAYD pricing since most drive less than average and very few drive significantly more than average (more than 15,000 annual miles).

Most motorists should benefit overall, including those who currently drive less than average in their rate class; any who would reduce their mileage to below average in response to this incentive; motorists who drive uninsured but would purchase insurance if offered PAYD; people who current cannot afford a car but would if offered PAYD; and motorists who drive high annual miles (and so would pay higher premiums) but value benefits such as reduced traffic congestion, accident risk and pollution emissions.

Potential Price Structures

Various PAYD insurance pricing options are discussed below.

1. Mileage Rate Factor (MRF)

PAYD can be implemented by incorporating annual mileage as a rating factor into premiums. Many insurers do offer small discounts for motorists who drive less than certain levels (such as 7,000 annual miles). However, these are currently based on motorists' self-reported estimates of their expected future mileage; since motorists cannot predict with certainty how much they will drive and there is no verification or adjustment at the end of the policy term, motorists significantly underestimate their annual mileage.[5] As a result, Mileage Rate Factor is currently inaccurate and can only apply a small portion of the actuarially justified weight on mileage.

The Mileage Rating Factor system can be improved by adding more mileage bands (such as every hundred miles),[6] verifying mileage based on a third party odometer reading,[7] and adjusting premiums at the end of the policy term, with a rebate to motorists who drove less than the number of miles they paid for, and a surcharge to motorists who drove more. This requires a mechanism to insure that motorists actually pay such surcharges.

2. Per-Mile Premiums (PMP)

This means that vehicle insurance is sold by the vehicle-mile (or kilometer) rather than the vehicle-year. Other rating factors are incorporated, so higher-risk drivers pay more per mile than lower-risk vehicles. For example, a $500 annual premium becomes 4¢ per mile and a $1,000 annual premium becomes 8¢ per mile, for vehicles in a rate class that averages 12,000 annual miles. This converts the unit of exposure from the *vehicle-year* to the *vehicle-mile* (or *-kilometer*), comparable to a mileage rate factor of one-mile bands.

Figure 1 suggests that marginal crash rates vary over the mileage range. This may justify marginally declining per-mile premiums, so, for example, the first 5,000 miles have a higher per-mile fee than in the 5,000-10,000 annual mile range, and above 10,000 miles per-mile premiums are lower still. However, many factors that contribute to the declining marginal crash rate can be incorporated directly using rating factors such as driving

[5] Insurers typically find that more than half of all motorists claim to drive less than 7,500 miles per year, although vehicles actually average about 12,000 miles (Butler, Butler and Williams, 1998).
[6] Since motorists are typically expected to reduce their mileage 5-10% in response to PAYD pricing, mileage bands must be this small to cause desired mileage reductions and benefits.
[7] Current California insurance law allows insurers to *request* mileage verification data, but may not *require* third-party odometer readings, so the resulting data are unverified and unreliable.

history and territory, so the need for marginally declining rates per vehicle-mile should decline over time as insurers gain experience with this rate structure.

With this system, motorists prepay for the miles they expect to drive during the term. For example, some might pay for 15,000 miles at the start of the term, while others might pay for just 5,000 miles at first and make additional payments as needed. Total premiums are calculated at the end of the term based on recorded mileage. Vehicle owners are credited for unused miles or pay any outstanding balance. Insurers would probably require purchase of a minimum number of miles per policy to insure that their transaction costs are recovered. There are several possible approaches to coverage:

A. *Coverage only on prepaid miles/minutes.* For example, if a vehicle owner pays for 5,000 miles, they have no coverage at 5,001 miles. This is the simplest approach and is appropriate for optional coverage, but could result in uninsured driving.

B. *Coverage regardless of prepayment.* Once a driver makes a minimum payment they have coverage for the policy term and pay for any outstanding miles at the end of the term. For example, at the start of the term a motorist might pay for 5,000 miles of coverage but drive 15,000 miles. At the end of the term they must pay for the outstanding 10,000 miles. This requires a mechanism to insure that motorists actually pay for any outstanding mileage, such as a bond or credit card charge that can be invoked if no final odometer reading is recorded, and requirements that outstanding insurance miles be paid before a vehicle can be reinsured and reregistered.

C. *Coverage regardless of prepayment, with late payment penalties.* This combines options A and B. Coverage is provided for all travel during the policy term but claims on unpaid miles have financial penalties, or post-payment have a surcharge. For example, deductibles could double for claims that occur past the prepaid number of miles, or miles paid after the end of the policy term have a 10% surcharge (6.0¢/mile would cost 6.6¢ if paid after the term). This also requires a mechanism to insure that motorists pay for outstanding mileage.

D. *Motorists initially pay premiums as they do now, but receive rebates for mileage below a certain level.* For example, they could receive 8¢ for each mile below 12,000 annual miles. However, once motorists reach the threshold they have no incentive to reduce mileage.

Per mile premiums require *odometer auditing* to collect accurate vehicle-mileage data. Odometer audits would be performed when a vehicle's insurance is renewed, in most cases annually. Audits involve these steps:

1. Check speedometer and instrument cluster for indications of tampering.
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 has been removed. This is unnecessary on most newer vehicles with electronic speedometers.
4. Check odometer accuracy (this is optional and could be performed on a random basis).
5. Record odometer reading and forward results to the vehicle licensing agency.

Such audits typically take 5-10 minutes and less if performed with other vehicle servicing, estimated to cost $5-15 per vehicle-year. Auditors could be certified by the state (similar to certification for other vehicle services, such as emission inspecting), by the insurance industry, or even by individual insurance companies. Electronic systems that report odometer readings from the vehicle engine computer using data loggers,[8] RFID, or mobile telephone systems could also be used to collect mileage data.

There are concerns that odometer fraud could be a problem, but most tampering can be detected during audits and crash investigations, and fraud would void coverage. Odometers are increasingly tamper-resistant. Odometer audits should provide data as accurate as that used in other common commercial transactions and more accurate than self-reported information now used for insurance pricing. Audits would provide additional benefits, including accurate mileage data for used-vehicle buyers, and allows other charges, such as registration fees, to become distance-based at minimal extra cost.

Per-Mile Premiums could be implemented as a consumer option. Motorists would choose between vehicle-year and vehicle-mile premiums, just as consumers can now choose their telephone service rates. Optional Per-Mile Premiums are likely to attract 25-50% of policies during the first few years, with penetration increasing over time as it become more competitive compared with vehicle-year pricing.

3. GPS-Based Pricing

This system GPS (Global Positioning System) transponders installed in vehicles to price insurance based on time and location. For example, a motorist might pay 7¢ per minute for urban-peak driving, 5¢ for urban-off-peak driving, and 3¢ per minute for driving in rural areas. This allows more actuarially-accurate pricing, but typically adds $150 or more in annual costs for equipment, billing and royalties, and raises privacy concerns, although such can be addressed by controlling vehicle location data management. Under most proposals, GPS-based pricing would be a consumer option. It would tend to attract low-mileage motorists, particularly those who want other GPS-based services and are unconcerned about loss of privacy, probably 2-5% of current policies.

Summary

The table below summarizes the pricing options evaluated in this report.

Table 1 **Summary of Distance-Based Pricing Options**

Name	Description
MRF	*Mileage Rate Factor* is incorporated into premiums.
Per-Mile, Mandatory	All vehicle insurance is priced by the mile or kilometer.
Per-Mile, Optional	Motorists may choose between vehicle-year or vehicle-mile premiums.
GPS-Based Pricing	Motorists may choose to purchase insurance based on when and where they drive using a GPS transponder installed in their vehicle.

This table summarizes the pricing options evaluated in the next section of this report.

[8] Such as Progressive's *TripSensor* system (http://newsroom.progressive.com/2004/august/tripsense.aspx).

Regulatory Strategies

Various regulatory strategies can encourage PAYD implementation.

PAYD Support and Encouragement

Insurance regulators can support PAYD implementation by specifically allowing PAYD premiums; allowing insurers to offer multiple rate structures and require third-party odometer readings; changing transportation and insurance regulations so they no longer assume that all policies are time-based; and removing unnecessary regulations such as excessive capital and surplus requirements, mandated rating factors, seasoning requirements, mandated board of directors sizes, and department of insurance body of law that duplicates those of secretaries of state. Insurance regulators should define minimum performance standards that rate structures must meet to be considered PAYD. State governments can help create mileage verification system, such as adding odometer audits as a separate component of vehicle emission inspection certification. Additional incentives should be explored, such as requirements that insurers offer PAYD pricing options, and regulatory preference for PAYD premiums.

Establish Minimum Weight for Mileage As A Rating Factor

Proposition 103 requires that mileage be the second most heavily weighted rating factor, after driving record and above years of driving experience. The insurance industry has failed to follow this law (Schwartz, 2004), in part because no standard methodology defines how to quantify weights, creating uncertainty (Litman, 2005). For example, an insurer that offers large premium reductions (say, 30%) for vehicles driven very low miles (say 3,000 annual miles), could argue that this satisfies Proposition 103, since the 30% reduction is larger than the values applied to most other rating factors, but because it only applies to a very low mileage band, such a reduction affects a tiny portion of policies and has little functional value. To satisfy Proposition 103 requirements and achieve PAYD insurance benefits, the CDI must define a methodology for quantifying such weights, which specifies factors such as how weights are calculated and mileage band maximum size.

Per-Mile Pricing

Per-mile pricing can be implemented by requiring insurers to change the unit of exposure for vehicle insurance from the vehicle-year to the vehicle-mile.[9] Insurers simply prorate existing premiums by dividing them by average annual mileage for each rate class, so a $600 annual premium becomes 5¢ per vehicle-mile, a $1,200 annual premium becomes 10¢ per vehicle-mile, and a $1,800 annual premium becomes 15¢ per vehicle-mile for a rate class that averages 12,000 annual miles per vehicle. This is probably the easiest to administrate since it is simple-to-calculate modification of existing rate structures. This approach could either be mandated for all policies, or required as a consumer option so each motorist could choose between current and PAYD premiums, just as consumers are able to choose different rate structures when purchasing telecommunications or cable television services.

If offered as a consumer option, odometer-based PAYD it is likely to attract 20-40% of policies, consisting of motorists who expect to drive relatively low mileage during the policy term, and so would represent 10-20% of vehicle travel. Mandatory PAYD pricing would apply to all vehicle travel, providing far greater total benefits.

[9] For more information see the *Cents Per Mile* website at www.centspermilenow.org

Verification and End-of-Policy Adjustment

PAYD pricing require systems to collect reliable mileage data at the start and end of the policy term, and to adjust premiums at the end of the policy term, so motorists receive rebates if they drove fewer miles than purchased, and pay extra if they drove more. No such system exists, which prevents insurers from placing actuarially-justified weight on annual mileage.[10] Some insurance companies request *service records* (such as odometer readings collected during vehicle servicing) but this is inadequate because the data only indicates "typical" past vehicle mileage, not the actual mileage driven during the policy term. Potential mileage verification methods are listed below from least to most reliable:

- Motorists report mileage, with mandatory spot-checks by brokers.
- Brokers collect odometer readings on all policies. This may be effective for policies sold by local brokers, but would not work for policies sold over the Internet.
- Certified odometer auditors collect mileage readings and check for signs of tampering.
- Motorists collect vehicle computer data using a portable data logger, and send the file electronically to their insurance company.
- An electronic mileage reporting system installed in the vehicle automatically sends mileage reports to a central database.
- GPS transponders in each participating vehicle track when and where it is driven.

These options offer various tradeoffs between data accuracy, operating costs and privacy. Self-reporting provides incomplete and unreliable data, but has minimal costs and privacy concerns. Systems that track vehicle travel provide complete and reliable data but are costly and raise privacy concerns. Certified odometer audits are probably the best approach for most vehicles. If PAYD is optional, insurers could offer incentives, such as price discounts for motorists who comply with verification activities.

Privacy Concerns

Some people fear that PAYD pricing invades motorists' privacy (Troncoso, et al. 2007). However, privacy is not a legitimate concern for PAYD pricing that is based only on vehicle mileage, information already collected during vehicle servicing and other transactions, and available to consumers who want to check a vehicle for possible odometer fraud.[11] Loss of privacy is only a risk with GPS-based pricing which tracks when and where a vehicle is driven, although such concerns can be addressed by controlling how data are processed and stored,[12] and many motorists choose to install GPS systems in their vehicles for navigation and emergency services In summary, privacy is not a legitimate concern provided that PAYD pricing is a consumer option so individuals can decide what data they share with insurers, or it uses mileage data which indicate nothing about when and were a vehicle is driven, or if location is tracked, there are adequate controls over how data are processed and stored.

[10] Current regulations allow insurers to request but cannot require service records and odometer audits.
[11] CarFax (www.carfax.com).
[12] Such as Skymeter Corporation (www.skymetercorp.com)

PAYD Pricing Performance Standards

It is important to define performance standards that an insurance policy must meet to be considered PAYD for marketing, legal requirements, and incentives (for example, policies that meet such standards could be marketed as *green insurance* and receive carbon credit funds). Below are factors that should be considered in such standards.

- *Weight given mileage.* Proposition 103 requires that mileage receive the second greatest weight when rating premiums, and in general, the more weight given to mileage the greater the savings provided to motorists who reduce their mileage, leading to greater incentive to reduce mileage and greater benefits such as financial savings, safety and emission reductions. However, there is no standard way to quantify this factor, so different industry and regulatory actuaries can interpret and implement it differently. A clearly-defined process should be established for quantifying rating factor weights.
- *Minimum mileage bands.* Current rating systems have large mileage bands, generally exceeding 1,000 miles, and they tend to be at extreme mileage ranges, such as below 5,000 or above 15,000, offering average motorists little incentive to marginally reduce their mileage. This reduces the incentive for motorists to reduce their mileage, since many will consider the next price category unachievable with reasonable effort. Potential savings and benefits are likely to increase if mileage bands become much smaller (such as 100 miles or individual miles), and are equally spaced, so a reduction from 12,000 to 11,900 annual miles provides the same savings as a 5,000 to 4,900 mile reduction.
- *Verification and adjustment*. Most current vehicle insurance policies incorporate mileage based on motorists' predictions of the amount of miles they expect to drive, with minimal effort to verify these estimates at the end of the policy term and adjust premiums to reflect actual mileage. This approach makes PAYD virtually impossible, since motorists cannot predict with any accuracy their future annual mileage (since their travel demands may change in the future), and insurers cannot trust the resulting mileage data (since motorists have both incentive and opportunity to underestimate their actual annual mileage). PAYD pricing requires collection of verifiable vehicle travel data, and a mechanism for adjusting premiums (providing refunds or collecting surcharges) at the end of the policy term based on actual mileage. Verification could be based on self-reported odometer readings with independent checks of at least 5%, third-party odometer audits of all vehicles, or automatic electronic reporting of vehicle travel data.
- *Minimum savings per mile reduced.* PAYD benefits are directly related to the magnitude of savings per vehicle-mile reduced. Actuarially-optimal savings average approximately 8¢ per vehicle-mile or more (calculated by dividing current average premiums by current annual mileage) with higher unit costs for higher-risk motorists.[13] A policy must achieve at least 80% of this value to be considered PAYD.
- *Accessibility*. This refers to the ease by which motorists, particularly lower-income motorists, can choose PAYD pricing, taking into account whether such policies are structured to meet low-income people's needs, the ease of obtaining information about PAYD policies, and the location of brokers.
- *Efficient pricing*. There should be no cross subsidies from the PAYD pool to the fixed-price insurance pool.

[13] The true optimal per-mile rate is probably higher, taking into account the external safety benefits that results from reduced mileage, that is, the reduction in risk and insurance claim costs to other vehicles that result when a vehicle reduces its annual mileage.

Table 2 summarizes recommended minimal standards for PAYD insurance, based on available information. Additional research may be needed to better define these concepts and values.

Table 2 **Summary of Recommended Minimum Standards for PAYD Pricing**

Indicator	Recommended Standard
Weight given mileage	Based on a clearly defined methodology developed by actuaries.
Minimum mileage bands	100 miles maximum, applied equally to all miles reduced.
Verification and adjustment	All vehicles have verified mileage data and end-of-policy-term adjustments.
Minimum savings per mile reduced	At least 80% of the prorated value, so a $1,000 premium for vehicles in a rating category that averages 12,000 annual miles would need to have at least 6.4¢ savings per mile reduced ($1,000/12,000 * 0.8).
Accessibility	PAYD policies that meet recommended standards are available to all motorists.
Efficient pricing	Lack of cross subsidies from PAYD pool to fixed-insurance price pool.

Responses to Concerns About Per-Mile Insurance

This section discusses concerns that have been raised about PAYD pricing.

Insurance pricing already incorporates mileage.
Some insurance companies incorporate mileage-related rate factors such as commute distance or estimated annual mileage, but none begins to approach actuarially accurate, marginal pricing, so they fail to give motorists accurate price signals.

Mileage is less important in predicting crashes than other rating factors.
Insurance industry claims that annual mileage is not a significant risk factor are based on inaccurate, self-reported data. New research based on independently-collected mileage data shows a strong relationship between mileage and crashes. Whether mileage is more or less important than other risk factors is irrelevant for PAYD pricing that incorporates other rating factors. Although it would not be actuarially accurate to use mileage instead of other rating factors, for example, to charge all motorists the same 6¢ per mile for insurance, actuarial accuracy increases significantly if mileage is added to other rating factors, so for example, a lower-risk motorist pays 3¢ per mile and a higher risk motorist pays 12¢ per mile.

Travel foregone could be lower risk than average, resulting in little crash reduction, and less insurance cost savings than reduced premium revenue.
This concern is technically valid, although there is no evidence that it is true. Available evidence indicates that PAYD reduces both high and low risk travel, and broad vehicle travel reductions result in proportionally greater crash reductions and insurance savings. Additional research and pilot projects that test the effects of distance-based pricing could address this concern.

PAYD pricing increases costs to low-income motorists.
PAYD provides significant savings and benefits to most lower-income motorists, including those who currently drive less than average; those who drive somewhat more than average but will reduce their mileage in response to this price incentive and so end up saving money; those who currently drive uninsured because they cannot afford insurance; and those who currently cannot afford to own an automobile due to high insurance costs, but can when PAYD becomes available. Butler (2000) describes how fixed insurance pricing creates a spiral of rising premiums and uninsured driving rates that harm low-income communities.

PAYD pricing unfairly increases costs to high-mileage drivers.
PAYD increases premiums for motorists who drive significantly more than average within their rate class. This is justified on actuarial grounds, and so increases fairness. Most motorists save money and benefit overall, particularly lower-income motorists, who tend to drive less than average within their rate groups.

PAYD pricing unfairly increases costs to rural residents.
Since territory is a rate factor, only rural motorists who drive significantly more than the average among rural residents would pay more. For example, motorists average 12,000 annual miles but rural motorists average 15,000, rural residents who drive 14,000 annual miles would save money, although this is more than the state average, because it is less than the rural average.

Automobile insurance reform should focus on equity, affordability and safety.
PAYD pricing helps achieve all of these goals. It increases equity by making premiums more actuarially accurate. It allows motorists to save money, makes vehicle ownership more affordable, and reduces costs for lower income motorists. It significantly increases road safety.

There are other ways to achieve safety, mobility, energy conservation and environmental goals
It is unnecessary to choose between PAYD pricing and other strategies. Distance-based pricing complements other strategies. Because of its multiple benefits, PAYD insurance can be one of the most cost-effective ways to achieve these objectives.

People need their cars too much to give them up. There will be no travel reduction.
PAYD is not expected to cause people to give up cars. There is extensive evidence vehicle operating costs affect vehicle travel activity. A 5-15% mileage reduction is projected based on standard motorist price responses.

Consumers will not accept this change.
Market surveys and pilot projects indicate significant consumer demand for distance-based pricing. A broad range of interest groups support PAYD pricing. Support should increase as consumers and citizens learn more about this concept.

Odometer fraud will be a major problem.
Although some fraud may occur, it should be minor overall, with fraud rates comparable to other common consumer transactions, and far lower than with current insurance pricing based on self-reported predictions of future mileage. Odometers are increasingly tamper resistant, regular odometer audits should discourage tampering, and the financial incentive for fraud is relatively low. Insurers' financial exposure would be minimal since odometer fraud voids coverage.

It increases administrative costs to insurers and inconvenience vehicle owners.
Although any price change adds short-term transition costs, these are minor, and tiny compared with total benefits. Odometer audits should cost $5-$15, and less if performed in conjunction with scheduled maintenance such as an oil change or emission inspection.

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. Several insurers now offer PAYD policies. There is nothing unique about pricing based on use. Prices for most goods are based on some measure of consumption, such as water and electric meters, and scales used to weigh food. Vehicle rentals and leases incorporate odometer-based price components. Vehicle insurance is unusual for having pricing that allows unlimited consumption (i.e., vehicle mileage).

PAYD pricing would be an invasion of privacy.
Odometer auditing does not identify when or where a vehicle has been driven, or provide any other information that could be considered private. Odometer readings are already collected during vehicle servicing, vehicle sales and crash investigations. Odometer readings are even sold by private companies to used vehicle purchasers. Odometer auditing simply standardizes the collection of this information. Odometer auditing would provide additional benefits. For example, it would prevent odometer fraud by used vehicle sellers (since a reliable record of past odometer readings would be easily available) and provide data useful for transport planning.

Some PAYD systems do track when and where a vehicle is driven, and so may raise legitimate privacy concerns. However, this would be a consumer option, and these systems can be designed with controls over how the vehicle location data are processed and stored, as with other personal data such as telephone calls and credit card transactions. Many motorists already choose to collect this information for security and auditing purposes.

Table 3 **Obstacles and Potential Solutions**

Obstacle	Potential Solutions
Misunderstandings. Many objections to PAYD pricing reflect misunderstandings of the concept. Some people believe it refers to Pay-At-The-Pump (insurance coverage funded through a fuel sales surcharge), are unaware of its full potential benefits, or have exaggerated estimates of its costs.	Educate stakeholders (policy makers, insurance professionals, insurance regulators, consumers) about PAYD, including how it would be implemented, and its real benefits and costs.
Uncertainty. Current rate structures are based on claim cost data collected by the vehicle-year. Although there is ample evidence that mileage is an important risk factor, actuaries have insufficient data to know exactly how to calculate mileage-based premiums.	Begin with a relatively small pilot project, using a basic prorated premium (i.e., current annual premiums divided by average annual mileage for each rate class), with an extra 5-15% margin to account for uncertainty. Adjust this rate as needed as the pilot project provides data.
Data accuracy. PAYD requires accurate mileage data. Self-reported data is unreliable.	Mileage data can be collected in many ways. The cheapest is for motorists to report odometer readings, verified with occasional spot-checks. The most costly is to install GPS transponders in each participating vehicle. An intermediate approach, which may provide the optimal balance between accuracy and cost, is to certify businesses (emission stations, service stations, and brokers) to perform odometer audits.
Exaggerated number of losers. Some people object to PAYD because they believe it would harm many groups, such as rural drivers (PAYD, as recommended here, would only increase costs for rural motorists who drive more than the average for rural motorists) or businesses (premiums for business vehicles already reflect their relatively high mileage).	Educate stakeholders about PAYD insurance real distributional impacts. To the degree that it is effective at reducing mileage and crash costs, most people should benefit overall. Even high mileage drivers can benefit overall due to reduced exposure to traffic congestion, accident risk and pollution emissions, or if they want to own multiple vehicles.
Regulatory constraints. Some insurance regulations discourage pricing reforms. For example, regulators often require insurers to provide data justifying rates, and some prohibit insurers from offering multiple rate structures. Regulations are complex and rate filings are costly (often costing a million dollars or more in data collection, analysis and paper works), which discourages small, innovative pilot projects.	Educate insurance regulators concerning the merits of PAYD with respect to insurance regulatory objectives. Collect data showing the actuarial basis for PAYD. Work with regulatory agencies to address specific obstacles to innovation and small pilot projects. Identify jurisdictions that have suitably supportive regulatory policies. Pass legislation (as in Oregon and Texas) which specifically allows PAYD insurance pricing.
Lack of incentive. Insurance companies currently perceive little incentive to implement innovative pricing options such as PAYD pricing.	Educate insurance company officials concerning opportunities to profit from PAYD pricing (the first companies to offer this product should attract significant new business). Provide financial incentives, such as tax breaks (as Oregon now does). Pass laws requiring insurance companies to offer PAYD, at least as an option. Fund PAYD research programs and pilot projects. Favor insurance companies that offer PAYD pricing in government contracts.

This table lists various obstacles to PAYD pricing, and potential solutions to them.

Conclusions and Recommendations

Motorists currently perceive vehicle insurance as a fixed vehicle cost with respect to annual vehicle travel. Marginal vehicle mileage reductions generally provide no insurance premium savings. However, various data indicates that crash and insurance claim costs per vehicle-year increase with annual vehicle mileage. Other risk factors also affect crash rates so it would be inappropriate to charge all motorists the same per-mile fee, but premiums become more actuarially accurate if mileage is incorporated with other rating factors, so lower risk motorists pays less per mile than higher risk motorists. As a result, incorporating mileage directly into premiums, called Pay-As-You-Drive (PAYD) insurance, increases economic efficiency and equity.

PAYD pricing is an elegant way to increase transport system efficiency because it is not a new fee, simply a different way to pay existing fees. It rewards motorists when they reduce mileage with the crash cost saving that result. This provides many benefits including increased safety, consumer cost savings, congestion reductions, road and parking cost savings, energy conservation, pollution reductions, and reduced uninsured driving. Even motorists who continue with current insurance pricing would benefit from reduced exposure to traffic risk, congestion and pollution emissions.

Insurance companies currently rely on motorists' self-reported estimates of future annual mileage, with no verification or adjust of premiums at the end of the policy term to reflect actual vehicle travel. As a result, they underweight mileage as a risk factor, which is economically inefficient and unfair. Basic PAYD is relatively simple to implement; it only requires verified odometer readings (called "odometer audits") at the beginning and end of the policy term. More complicated data collection systems may be offered as a consumer option, but they increase implementation costs and raise privacy concerns.

The California Department of Insurance (CDI) can maximize benefits by defining performance standards that policies must meet to be considered PAYD. These should include a specific methodology for quantifying the relative weight given different factors in a rating system, maximum mileage band size, minimum verification and price adjustment methods, minimum accessibility to PAYD policies for lower-income motorists, and prohibitions on cross-subsidies from PAYD to fixed-rate pricing pools. One of the best indicators of PAYD pricing is the average insurance cost savings per vehicle-mile for a 10% reduction from the fleet average annual mileage (e.g., from 12,000 to 10,800 annual miles), which should approach 8¢.

Many objections to PAYD are technically inaccurate or can be addressed with appropriate policies. Most types of PAYD impose neither large transaction costs nor loss of privacy. Mileage data can be collected through annual odometer audits performed by service stations and insurance brokers. With most modern vehicles, odometer fraud is difficult and can be detected with simple precautions. Rural residents as a group would not bear higher premiums; only those who drive more than average among rural residents would pay more with PAYD pricing.

References and Resources of More Information

Jason E. Bordoff (2008) *Pay-As-You-Drive Car Insurance*, Brookings Institution (www.brookings.edu/articles/2008/spring_car_insurance_bordoff.aspx).

Jason E. Bordoff and Pascal J. Noel (2008), *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*, The Brookings Institution (www.brookings.edu); at www.brookings.edu/~/media/Files/rc/papers/2008/0417_payd_bordoff/0417_payd_bordoff.pdf.

Patrick Butler (1992), *Operation of an Audited-Mile/Year Automobile Insurance System Under Pennsylvania Law*, Cents Per Mile Now (www.centspermilenow.org); at www.casact.org/pubs/forum/93sforum/93sforum.pdf.

Patrick Butler (2000), *Why The Standard Automobile Insurance Market Breaks Down In Low Income Zip Codes*, Report to the Texas House Committee on Insurance; at www.centspermilenow.org/633b-4522.pdf. Also see "Pay-per-Mile Auto Insurance" *Consumer Economic Issues in America*, (2003); at www.centspermilenow.org/652Garma.pdf.

Patrick Butler, Twiss Butler and Laurie Williams (1998), "Sex-Divided Mileage, Accident, and Insurance Cost Data Show that Auto Insurers Overcharge Most Women," *Journal of Insurance Regulation*, Vol. 6, No. 3&4.

CDI (2008), *NOTICE OF WORKSHOP Regarding "Pay-As-You-Drive" Automobile Insurance*, REG-2008-00020 Notice Date: May 23, 2008, California Department of Insurance (www20.insurance.ca.gov); at www20.insurance.ca.gov/epubacc/REG/112249.htm.

Cambridge Systematics (2006), *Mileage-Based User Fee Demonstration Project: Potential Public Policy Implications of Pay-As-You-Drive Leasing and Insurance Products*, Final report 2006-39C, Minnesota Department of Transportation (www.lrrb.org); at www.lrrb.org/pdf/200639C.pdf.

CCAP (2005) *Transportation Emissions Guidebook: Land Use, Transit & Transportation Demand Management*, Center of Clean Air Policy (www.ccap.org/guidebook). This Guidebook provides information on various smart growth and mobility management strategies, including rules-of-thumb estimates of VMT and emission reductions.

Cents Per Mile For Car Insurance (www.centspermilenow.org) is a website that promotes "cents per mile" vehicle insurance as allowed by legislation passed in the state of Texas in 2001.

Stephen J. Dubner and Steven D. Levitt (2008), "Freakonomics: Not-So-Free Ride," *New York Times*, April 20, 2008, (www.nytimes.com/2008/04/20/magazine/20wwln-freakonomics-t.html).

Aaron S. Edlin (2003), "Per-Mile Premiums for Auto Insurance," *Economics for an Imperfect World: Essays In Honor of Joseph Stiglitz*, MIT Press; at: http://works.bepress.com/aaron_edlin/28.

Aaron S. Edlin and Pinar Karaca Mandic (2006), "The Accident Externality from Driving," *Journal of Political Economy*, Vol. 14.5, pp. 931-955; at http://works.bepress.com/aaron_edlin/21.

Environmental Defense PAYD Website (www.actionnetwork.org/campaign/payd) provides information on a campaign to promote pay as you drive vehicle insurance.

Keri Funderberg, Michael Grant and Ed Coe (2003), "Changing Insurance One Mile At A Time," *Contingencies* (www.contingencies.org/novdec03/changing.pdf), Nov./Dec. 2003, pp. 34-38.

Allen Greenberg (2007), *Designing Pay-Per-Mile Auto Insurance Regulatory Incentives Using the NHTSA Light Truck CAFE Rule as a Model*, Paper 07-3457, TRB Annual Meeting (www.trb.org); at www.vtpi.org/07-3457.pdf.

Randall Guensler, Adjo Amekudzi, Jennifer Williams, Shannon Mergelsberg and Jennifer Ogle (2003), "Current State Regulatory Support for Pay-as-You-Drive Automobile Insurance Options," *Journal of Insurance Regulation*, National Association of Insurance Commissioners (www.naic.org) Volume 21, No. 3, Spring 2003.

Christine Hagerbaumer (2004), "Drive-By Rates: Can Pay-As-You-Drive Insurance Attract Good Risks And Gain Insurers An Environmentally Responsible Image?" *Best's Review*, April, pp. 68-69.

Winston Harrington and Ian W.H. Parry (2005), "Pay-As-You-Drive Car Insurance," *New Approaches on Energy and the Environment*, Resources for the Future (www.rff.org).

Todd Litman (1997), "Distance-Based Vehicle Insurance as a TDM Strategy," *Transportation Quarterly*, Vol. 51, No. 3, Summer 1997, pp. 119-138; at www.vtpi.org/dbvi.pdf.

Todd Litman (2001), *Distance-Based Vehicle Insurance Feasibility, Benefits and Costs: Comprehensive Technical Report*, VTPI (www.vtpi.org); at www.vtpi.org/dbvi_com.pdf.

Todd Litman (2004), *Pay-As-You-Drive Pricing For Insurance Affordability*, VTPI (www.vtpi.org); at www.vtpi.org/payd_aff.pdf.

Todd Litman (2005), "Pay-As-You-Drive Pricing and Insurance Regulatory Objectives," *Journal of Insurance Regulation*, Vol. 23, No. 3, National Association of Insurance Commissioners (www.naic.org), Spring; at www.vtpi.org/jir_payd.pdf.

Todd Litman (2007), *Pay-As-You-Drive Pricing in British Columbia: Backgrounder*, VTPI (www.vtpi.org); at www.vtpi.org/paydbc.pdf.

Todd Litman (2007), *Win-Win Emission Reduction Strategies: Smart Transportation Strategies Can Achieve Emission Reduction Targets And Provide Other Important Economic, Social and Environmental Benefits*, VTPI (www.vtpi.org); at www.vtpi.org/wwclimate.pdf.

Todd Litman and Steven Fitzroy (2005), *Safe Travels: Evaluating Mobility Management Traffic Safety Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/safetrav.pdf.

NMA (2007), *NMA's Position on Auto Insurance*, National Motorists Association (www.motorists.org/insurance).

Ian W. H. Parry (2004), "Comparing Alternative Policies to Reduce Traffic Accidents," *Journal of Urban Economics*, Vol. 54, No. 2 (www.elsevier.ocm/locate/jue), Sept. 2004, pp. 346-368.

Ian W.H. Parry (2005), *Is Pay-As-You-Drive Insurance a Better Way to Reduce Gasoline than Gasoline Taxes?*, Resources for the Future (www.rff.org/Documents/RFF-DP-05-15.pdf).

Ian W. H. Parry, Margaret Walls and Winston Harrington (2007), *Automobile Externalities and Policies*, Discussion Paper 06-26, Resources for the Future (www.rff.org); at www.rff.org/rff/Documents/RFF-DP-06-26-REV.pdf.

Andrew Schwartz (2004), *Evaluating Insurer Compliance with Proposition 103: Promoting Fair and Affordable Auto Insurance Pricing in California*, U.S. Environmental Protection Agency.

Sightline (2003), *NEW Facts: Pay-As-You-Drive Car Insurance*, NorthWest Environment Watch (www.sightline.org/research/sust_toolkit/solutions/payd).

Carmela Troncoso, George Danezis, Eleni Kosta, Bart Preneel (2007), *PriPAYD: Privacy Friendly Pay-As-You-Drive Insurance*, Workshop on Privacy in the Electronic Society, 2007 (www.csc2.ncsu.edu/workshops/wpes07/accepted.html), COSIC; at www.cosic.esat.kuleuven.be/publications/article-944.pdf.

William Vickrey (1968), "Automobile Accidents, Tort Law, Externalities and Insurance: An Economist's Critique," 33 *Law and Contemporary Problems*, pp. 464-470; at www.vtpi.org/vic_acc.pdf.

Tanja Vonk, Marten Janse, Jos Dings and Huib van Essen (2003), *Pay As You Drive (PAYD): Scope for a Variable Car Insurance Premium in the Netherlands?* CE Delft (www.ce.nl/eng/redirect/thema_pricing_index.html).

VTPI (2008), "PAYD Insurance," *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tdm/tdm79.htm.

Tom Wenzel (1995), *Analysis of National Pay-as-you-Drive Insurance Systems and other Variable Driving Charges*, Energy & Environment Division, Lawrence Berkeley Laboratory; at www.osti.gov/energycitations/product.biblio.jsp?osti_id=125357.

Steve Winkelman (2007), *Travel Demand and Urban Form: Lessons and Visions*, Asilomar Conference on Transportation and Climate Policy August 22, 2007; at www.its.ucdavis.edu/events/outreachevents/asilomar2007/presentations/Day%201%20Session%203/Winkelman%20Intro%20to%20Asilomar%20Demand%20Session%20(8.22.07).pdf.