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"Efficiency - Equity - Clarity"

Socially Optimal Transport Prices and Markets

Principles, Strategies and Impacts

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Abstract

This paper investigates the level of mobility that is socially optimal, that is, the amount and mix of transport activity that consumers would choose in an efficient market that reflects the principles of efficient pricing, consumer options and optimal planning. It discusses market principles, identifies transport market distortions and ways to correct them, estimates how such reforms would affect mobility, and investigates the resulting economic impacts. This analysis indicates that in a more optimal market, consumers would choose to drive significantly less, use alternative modes more, choose more accessible land use options, and be significantly better off overall as a result. Transport market reforms face various obstacles but these can be minimized through appropriate implementation. Although previous studies have evaluated individual transport market distortions and reforms, this is one of few that considers their cumulative impacts.

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Preface: What Is Best?

There is nothing worse than a house that is drafty and cold, except one that is stuffy and hot. There is nothing worse than bland soup, except soup that is too salty or spicy. The Duchess of Windsor once said that a woman can never be too thin or a man too rich, but there is really nothing attractive about anorexic, greedy, single-minded people. With few exceptions, the best option is one that balances various objectives, called *optimality* in this report.

This study investigates the amount of mobility (physical travel) that is truly optimal. Although a certain amount of mobility is certainly desirable, it is wrong to assume that more is always better. Beyond an optimal level, increased mobility is harmful to consumers and society because it wastes resources – time, money, land and energy – with more beneficial alternative uses.

Although few motorists want to give up motor vehicle travel altogether, many indicate that they would prefer to drive somewhat less and rely more on alternatives, provided that they are convenient, comfortable, safe and affordable. For various reasons – price structures that make driving seem cheap, limited travel options, and automobile-oriented land use patterns – many people end up devoting more time and money to automobile travel than they consider optimal.

This has important implications since many current planning practices favor *mobility* over *accessibility*, *faster* modes over *slower* modes, and *indirect* over *direct* pricing of roads and parking facilities. These practices increase mobility, but can make consumers worse off overall. Described more positively, market reforms described in this report can help reconcile existing conflicts between our preferences and our policies.

I will begin with the proposition that in no other major area are pricing practices so irrational, so out of date, and so conducive to waste as in urban transportation.

- William Vickrey, "Pricing in Urban Transportation," *American Economic Review*, 1963.

Introduction

Markets are systems through which resources (goods, services, land, labor, etc.) are exchanged. An efficient market is like a well-tuned machine: Consumers can choose from various goods and services, so they can select the combination that best meets their needs and preferences. Prices provide signals that indicate production costs and consumer values. Competition stimulates efficiency and innovation. In these ways, markets efficiently and equitably allocate resources, making everybody better off overall.

But love of markets must not be blind. Optimal markets must reflect certain principles, including efficient pricing, adequate consumer options, and optimal planning practices. This paper evaluates how well current transportation markets reflect these principles, investigates market distortions and corrections, and estimates the changes in mobility that would occur under optimal market conditions.

For this analysis, *transportation markets* include the supply and price of all transport system components, including vehicles, fuel, facilities and services. Because location decisions affect transport, land use policies are also components of transport markets.

This paper investigates how to determine the amount of mobility (physical travel) that is truly optimal. It asks, "What amount and mix of travel would people choose in a market with efficient prices and viable options and neutral policies."

This research has important implications and practical applications. It identifies a variety of existing market distortions and potential reforms to correct them, including some that are often overlooked in conventional transport planning. It can help identify policies and programs that improve overall transportation system efficiency. It can help establish *mobility management* (also called *transportation demand management* or *TDM*) targets.

Although numerous studies have investigated individual transportation market distortions and reforms, this is one of the few that attempts to evaluate them comprehensively. A few that do include Lee (1992); Litman, Komanoff and Howell (1998); Dings, et al (2002); Proost, et al (2002); Parry, Walls and Harrington (2007). This report builds on previous research by the Victoria Transport Policy Institute, including the report *Transportation Cost and Benefit Analysis*, which evaluates the costs of various types of transportation; the *Online TDM Encyclopedia*, which describes various mobility management strategies and evaluates their benefits and costs; and *Comprehensive Transportation Planning*, which investigates the degree to which current transport planning considers and impacts and options, and recommends reforms for more comprehensive analysis.

Market Principles, Distortions and Reforms

Economic optimality refers to market conditions that maximize *social welfare* (total human happiness) and reflect equity objectives (fairness and progressivity). An *optimal market* refers to the physical and social structures that allow this to occur. To achieve optimality a market must reflect certain principles including *efficient pricing*, *adequate consumer options* and *economic neutrality* (Gómez-Ibáñez, Tye and Winston, 1999; Vermeulen, et al, 2004; Hartford, 2005; Ricci, et al, 2006; Litman, 2006a). Violations of these principles are called *market distortions*, and corrections of distortions are called *market reforms*. This section describes these principles, investigates the degree to which they are reflected in current transport markets, describes reforms to make transport markets more optimal, and the changes in mobility that would result.

Efficient Pricing

Price refers to users' *direct, perceived, variable costs*, the costs that directly affect their consumption decisions. Market efficiency requires that prices reflect *marginal costs* (the incremental cost of producing a good) unless a subsidy is specifically justified. Thus, goods that cost \$1.00 to produce should be priced at \$1.00, not 50¢ (*underpricing*, which encourages inefficient consumption) or \$2.00 (*overpricing*, which limits consumption and so reduces consumer benefits). Efficient pricing tests consumer willingness-to-pay, which prevents society devoting \$2.00 to produce goods that users only value at \$1.00. Scarce resources not rationed by price will be rationed by congestion. Although consumers may dislike both pricing and congestion, pricing increases efficiency by allowing higher-value trips to outbid lower-value trips, and provides revenue, a bonus to society. If an activity has external costs, prices will be less than marginal costs, and a special tax (called a *Pigouvian* tax after the economist who proposed it) will be justified for efficiency.

Table 1 Road and Parking Pricing Methods ("Pricing Methods," VTPI, 2006)

Type	Description	Operating Costs	User Costs	Price Adjustability
Pass	Motorists must purchase a pass before driving or parking in a particular area.	Low to medium	Medium	Low
Toll Booths	Motorists stop and pay at a booth.	Very high	Very high	Medium
Mechanical Parking Meters	Motorists insert coins into a curbside meter to park for a certain time period.	High	High	Low
Electronic Parking Meters	Motorists pay by coin, credit card or mobile telephone to park.	Medium	Medium	High
Mileage Tracking	Odometer audits or electronic reporting.	Low	Low	Low
Electronic Tolling	Automatically bills users when they pass a point in the road system.	Medium	Medium	High
Location Tracking	Transponders installed in each vehicle automatically tracks location and bills fees.	High	Medium	High

Some pricing methods have lower costs and better adjustability, making pricing more feasible.

Optimal pricing requires trade-offs among various objectives, including transaction cost minimization, efficiency, equity, and strategic planning objectives. For example, in some situations it may be appropriate to leave roads, parking or transit services unpriced, or apply a flat rather than variable charges, to reduce costs to consumers and agencies of collecting fees, or because user fees are considered more regressive than other funding options. As a result, there are often differences between *theoretical* optimal pricing (that ignore transaction costs) and *functional* optimal pricing (which considers transaction costs). This difference can be reduced with newer pricing methods that minimize transaction costs and improving adjustability, as summarized in Table 1.

Some economists advocate *short run marginal cost* (SRMC) pricing, so, for example, road use fees only reflect operating and maintenance costs but not construction or land costs, which they consider *sunk*. Others argue that facility users as a group should bear all costs, which requires pricing based on *long-run average costs* (LRAC), also called *average cost*, *cost recovery* or *full cost pricing*. There are several reasons for this (Roth, 1996; Lee, 1997; van Essen, et al, 2004; Metschies 2001 and 2005).

First, over time most costs become marginal. For example, land has opportunity costs since it can be converted to other uses, and facilities eventually require major repairs. Cost recovery pricing tests whether a facility should continue to exist over the long run.

Table 2 Motor Vehicle Cost Categories

Shorter Term Marginal Costs	Longer Term Marginal Costs	Sunk Costs
<ul style="list-style-type: none"> • Vehicle operation. • Travel time. • Facility wear. • Congestion imposed on others. • Accident risk. • Pollution damages. 	<ul style="list-style-type: none"> • Vehicle and facility capital costs. • Opportunity cost of facility land. • Facility maintenance. • Land value. • Land use impacts (such as sprawl) 	<ul style="list-style-type: none"> • Past planning and unrecoverable construction costs.

This table indicates the degree to which various transport costs are marginal.

Second, horizontal equity requires that users bear the costs they impose unless a subsidy is specifically justified. There is no apparent reason that transport activity should be subsidized, causing less mobile consumers to subsidize people who are more mobile (although targeted subsidies may be justified for specific people or activities).

Third, most goods are priced for cost recovery so economic neutrality requires similar pricing of transport facilities and services unless subsidies are specifically justified. For example, rail transport prices include rent and taxes on rail rights-of-way, and return (interest and profits) on capital investments. Agricultural product prices include farmland rent and property tax costs, general taxes on most inputs, as well as normal return on capital. Failing to charge motorists the equivalent of rent and property taxes on roadway land, and general taxes on inputs such as fuel, underprices road transport relative to rail and transport relative to other land used or investments. As Lee (1995) explains,

“From a short-run perspective, FCP (Full Cost Pricing) is primarily an equity issue, but in the long run it has consequences for efficiency. First, agencies forced to recover all costs from their consumers will seek and find ways to reduce costs for each level of output...FCP is aimed at efficiency through the concept of economic neutrality. Unless there is a particular reason to favor one activity or enterprise over another, then the government should attempt to make all decisionmaking in the private sector neutral with respect to economic choices of pricing, investment, and whether to stay in business.”

Only special taxes and fees paid by motorists should count toward cost recovery, not general taxes or fees paid to compensate other costs. There is room for debate concerning what portion of congestion pricing, vehicle emission fees, parking fees and traffic fines should count toward roadway cost recovery.

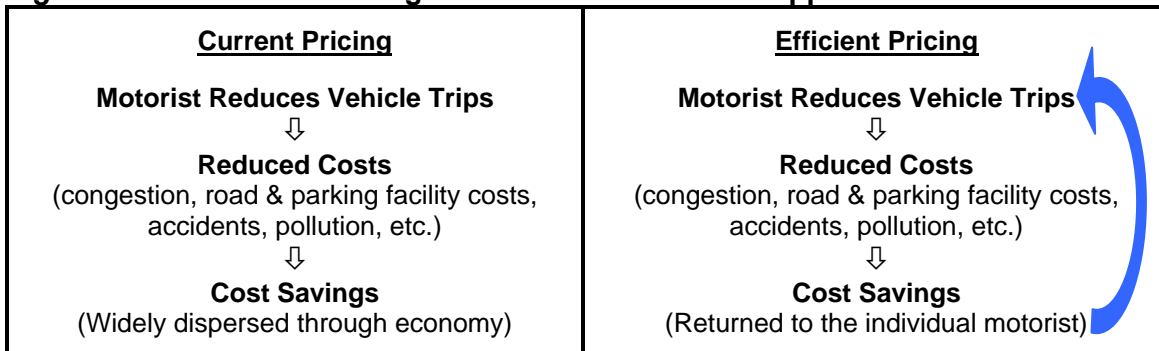
Possible Justifications for Subsidies and Underpricing

Underpricing and subsidies may sometimes be justified for the following reasons:

- To avoid transaction costs required for efficient pricing (such as parking meters and toll collection).
- For equity objectives, such as improved mobility or cost savings for disadvantaged people.
- To take advantage of scale economies (declining marginal costs or increased benefits).
- To achieve strategic objectives, such as stimulating a particular industry or region.

Consumers often assume they benefit from underpricing, such as free roads and parking. But these are not really free; consumers pay indirectly through higher taxes (for public roads and parking facilities), higher retail prices (for business-supplied parking) and lower wages (for employee parking). In addition, underpricing increases external costs such as congestion. The choice therefore is really between paying *indirect for congested facilities* or *directly for uncongested facilities*. Overall, consumers are better off paying directly because this offers more opportunity to save: If roads and parking facilities are funded indirectly, people pay regardless of how much they drive, but with direct user fees those who reduce their consumption capture the resulting savings (Figure 1).

Figure 1 Efficient Pricing Gives Consumers More Opportunities to Save

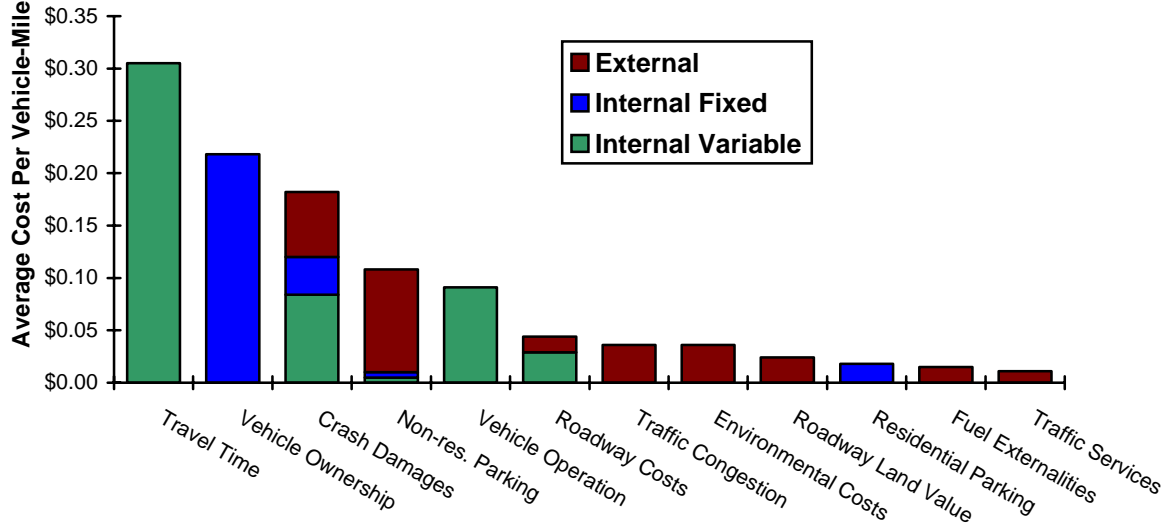


With current pricing, savings from reduced driving are dispersed through the economy. Efficient pricing returns more savings to individuals who reduce their driving.

Price Distortions

Several studies have investigated transport costs and optimal pricing (Murphy and Delucchi, 1998; Vermeulen, et al, 2004; Litman, 2007a; *European Transport Pricing Initiatives*; Parry, Walls and Harrington, 2007). Figure 2 illustrates an estimate of these costs.

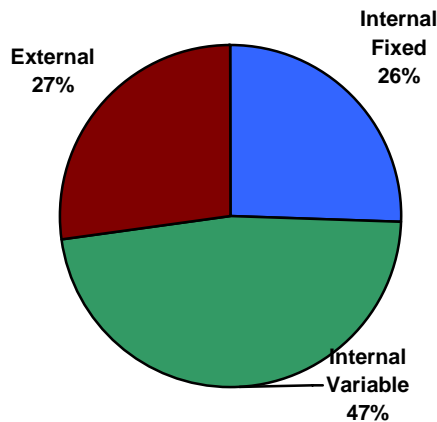
Figure 2 Estimated Automobile Transport Costs (Litman, 2007a)



This figure illustrates the estimated costs of motor vehicle ownership and use.

These costs are divided into three categories: *Internal Variable* (borne directly by users based on amount of vehicle-travel), *Internal Fixed* (borne directly by users but not directly related to vehicle-travel) and *External* (costs imposed on others). Figure 3 illustrates the distribution of these costs.

Figure 3 Automobile Cost Distribution (“Transport Costs,” VTPI, 2006)



More than a quarter of vehicle costs are external and another quarter is internal but fixed.

This indicates that more than half of vehicle costs are either external or internal-fixed. Both external and internal-fixed costs are forms of underpricing that tend to be inefficient and inequitable. For example, parking subsidies are unfair because they force households that own fewer than average vehicles to subsidize others that own more than average vehicles, and fixed automobile insurance premiums are inefficient because the costs they represent (accidents and therefore insurance claim) increase with annual vehicle travel. Such pricing encourages motorists to maximize their driving in order to get their money's worth, and so increases external costs.

Several specific market distortions contribute to this underpricing:

- A portion of roadway costs (about a third in the U.S.) are funded by general taxes (which people pay regardless of how much they travel) rather than user fees. Fuel tax rates, which are generally a fixed amount per unit of fuel sold, have not increased with inflation or increased vehicle fuel efficiency, so revenue per vehicle-mile has declined.
- User fees and taxes often fail to accurately reflect factors such as the type of vehicle, driver ability, time and location. This creates cross-subsidies among vehicle users, and fails to encourage the most efficient vehicle and travel behavior.
- Insurance and registration fees are fixed, and so fail to reflect the degree to which crash and roadway costs increase with mileage. Fixed fees encourage motorists to maximize their mileage in order to “get their money's worth” from their fixed investments.
- Most parking is provided free, significantly subsidized, and when priced, fees seldom reflect marginal costs. This results, in part, from zoning codes and development practices which require generous amounts of parking to be bundled with building costs, rather than charged directly to parking facility users.
- Roadway land is treated as a sunk cost. User fees seldom include the equivalent of rent or taxes on transport facility land. This underprices transport relative to other land uses, and space-intensive modes relative to space-efficient modes.
- Current tax policies stimulate mobility and favor automobile travel over other modes by making subsidized parking and company cars attractive employee benefits (Moret, Ernst & Young, 1994). A typical employee would need to earn about \$2,000 in pretax income to pay for a parking space that costs their employer \$1,000 as a business expense. A significant portion of company car mileage (typically 15-20% according to Runzheimer International surveys) is for personal use.

Optimal Prices

This section discusses optimal pricing of various vehicle costs. For more information on costs see Vermeulen, et al (2004) and Litman (2007a). For more information on pricing reforms see ECMT (2000), Dings, et al (2002), van Essen, et al (2004) and VTPI (2006).

Congestion Pricing

Congestion pricing (also called *value pricing*) consists of tolls structured to reduce traffic volumes on specific roadways to optimal levels, which typically means approximately Level-Of-Service C (TTI, 2005; “Congestion Costs,” Litman, 2007a). Currently, only a small portion of traffic is tolled, and few tolls are structured to optimize congestion. About 20% of vehicle travel occurs under urban-peak conditions and perhaps half of this experiences congestion, indicating 5-15% of vehicle-travel should bear congestion tolls. Optimal congestion pricing increases as transaction costs decline, for example, if electronic pricing methods replace toll booths. Although only with experience is it possible to determine optimal prices, available modeling suggests that fees would probably vary from zero on uncongested roads to more than 20¢ per vehicle-mile on highly congested corridors, averaging 5-10¢ per urban-peak mile, and 1-2¢ overall (Vermeulen, et al, 2004; Litman, 2007a). Fees can vary based either on a fixed schedule or they can be *dynamic*, meaning that rates change in direct response to congestion levels.

Conventional congestion cost analysis only measures the delays vehicles impose on other vehicles. More comprehensive analysis also considers delays motor vehicle traffic imposes on pedestrians and cyclists, called the *barrier effect*, which is estimated to represent 0.5-1.5¢ per vehicle-mile, depending on how it is calculated (“Barrier Effect,” Litman, 2007a). Congestion pricing requires location-based road tolls that reflect the delays imposed at specific times and locations, taking account demand (the amount of nonmotorized travel that would occur if given the opportunity), and the degree a motor vehicle hinders this travel. It could be argued that the delay motorists impose on walkers and cyclists is offset by delays nonmotorized travel imposes on motorists, reducing the equity justification for compensation, but nonmotorized travel is more vulnerable and used by disadvantaged populations (nonmotorized travel is considered more “basic” than automobile travel), so these impacts are not necessarily symmetrical.

The table below indicates estimated optimal congestion fees. The middle and lower-bound estimates reflect current pricing methods, while the upper bound estimate reflects the theoretical optimum using universal vehicle location systems. Revenues can be used to improve travel options, help pay roadway costs (in which case it should be subtracted from road user fees described next), or for general revenue (as a Pigouvian tax).

Table 3 Congestion Tolls Summary (Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Congestion costs imposed on vehicles	0.0¢	0.5¢	1.0¢	2.0¢
Delays to nonmotorized travel (barrier effect)	0.0¢	0.0¢	0.5¢	1.0¢
<i>Total</i>	0.0¢	1.0¢	2.0¢	3.5¢

This table indicates the range of optimal congestion tolls.

Roadway Costs

Optimal pricing requires that motorists directly pay roadway costs. *Roadway cost allocation* studies calculate the costs imposed by various vehicle types and appropriate fees (Jones and Nix, 1995; TC, 2006; Vermeulen, et al, 2004; van Essen, et al, 2004). The most recent U.S. highway cost allocation study (FHWA, 1997) found that 1997 roadway expenditures averaged about 4.7¢ per vehicle-mile and user fees paid about 3.6¢ per vehicle-mile, leaving about 1¢ per vehicle-mile in costs borne through general taxes, a share that has since increased (Wach, 2003).

Optimal pricing also requires that vehicle users pay directly for traffic services such as policing, traffic lights and emergency services, estimated to average 1-4¢ per vehicle mile (“Traffic Services,” Litman, 2007a). In addition, efficiency and equity require that road users pay the equivalent of rent and property taxes on roadway land, an estimated annualized value of about \$50-150 billion in 2005 dollars, or about 2-6¢ per VMT (Lee, 1995; Litman, 2007a). Roads also impose various land use impact costs, such as stormwater management costs, heat-island effects and habitat loss (“Land Use Impacts,” Litman, 2007a). Optimal road pricing should include these costs, at least the most direct, such as stormwater management and habitat replacement expenses, and possibly also compensation for indirect costs such as heat island effects and habitat loss.

A *weight-distance fee* (a fee based on a vehicle’s weight multiplied by its mileage) is appropriate for roadway costs, which more accurately reflects such costs than fuel taxes and is cheaper to implement than vehicle location systems (FHWA, 1997). In addition, existing vehicle registration and license fees can be prorated by mileage, so for example, an automobile that currently pays \$360 per year for registration and licensing would pay 3¢ per mile. Whether this adds to or replaces other charges depends on the intent of these fees. If they are considered road user charges they can be replaced by mileage fees. If they are a general property tax they should be charged in addition to mileage fees. This fee would average about 2¢ per automobile mile, assuming current vehicle fees average \$250 annually. Other currently fixed taxes and fees could also be converted to distance-based charges, including vehicle purchase taxes and lease fees.

Tolls currently pay only about 5% of total roadway costs, averaging about 0.3¢ per vehicle-mile. Table 4 indicates estimates of various road use fees. These would vary by vehicle type, with lower fees for smaller vehicles and higher fees for large vehicles.

Table 4 Roadway Fees Summary (Average Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Roadway expenditures	0.3¢	1.0¢	3.0¢	5.0¢
Traffic services	0.0¢	0.5¢	1.0¢	2.0¢
Roadway land	0.0¢	2.0¢	4.0¢	6.0¢
Roadway land use impacts	0.0¢	0.0¢	1.0¢	2.0¢
Replaces fixed registration fees	0.0¢	0.0¢	2.0¢	4.0¢
<i>Totals</i>	<i>0.3¢</i>	<i>3.5¢</i>	<i>11.5¢</i>	<i>20¢</i>

This table summarizes the components of an optimal road user fee.

Accident Costs

Accident costs include the uncompensated damages and risks each vehicle imposes on other road users (Litman, 2007a). Insurance is intended to compensate these costs, but it is inefficiently priced. As Nobel Prize winning economist William Vickrey commented in 1968, “*the manner in which premiums are computed and paid fails miserably to bring home to the automobile user the costs he imposes in a manner that will appropriately influence his decisions.*” There are two major problems with current insurance pricing.

First, prices fail to reflect vehicle use. Current insurance premiums are considered fixed costs, not directly affected by annual vehicle mileage, although this does affect crash and claim rates (Vickrey, 1968; Edlin and Mandic, 2001). Optimal pricing requires *Pay-As-You-Drive* (PAYD) insurance pricing, which prices premiums by the vehicle-mile (or vehicle-kilometre), incorporating other rating factors such as driver history, vehicle class, and territory (“PAYD Insurance,” VTPI, 2006). With current premiums averaging \$1,000 per vehicle-year, PAYD premiums would average about 7¢ per mile.

Second, a significant portion of crash costs (particularly non-market damages such as pain and reduced quality of life from injuries) are currently uncompensated. These costs are ultimately borne by injured parties and by society through medical programs, disability compensation and welfare programs. Described differently, society should be willing to spend more to prevent accidents than what is paid in compensation, since overly-generous compensation encourages inefficient risk-taking. Efficient pricing should reduce driving so, for example, vehicle-travel that imposes 10¢ per mile in crash costs does not occur if users are only willing to pay 5¢. With optimal pricing motorists would pay about 10¢ per mile on average, based on prorating existing insurance premiums, which would average about 7¢ per vehicle-mile, increased 30-50% to internalize currently uncompensated external crash costs (Vermeulen, et al, 2004; van Essen, et al, 2004).

Table 5 Accident Fees Summary (Average Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Prorated insurance premiums	0.0¢	4¢	7¢	9¢
Currently uncompensated crash costs	0.0¢	1¢	3¢	5¢
<i>Totals</i>	<i>0.0¢</i>	<i>6¢</i>	<i>10¢</i>	<i>14¢</i>

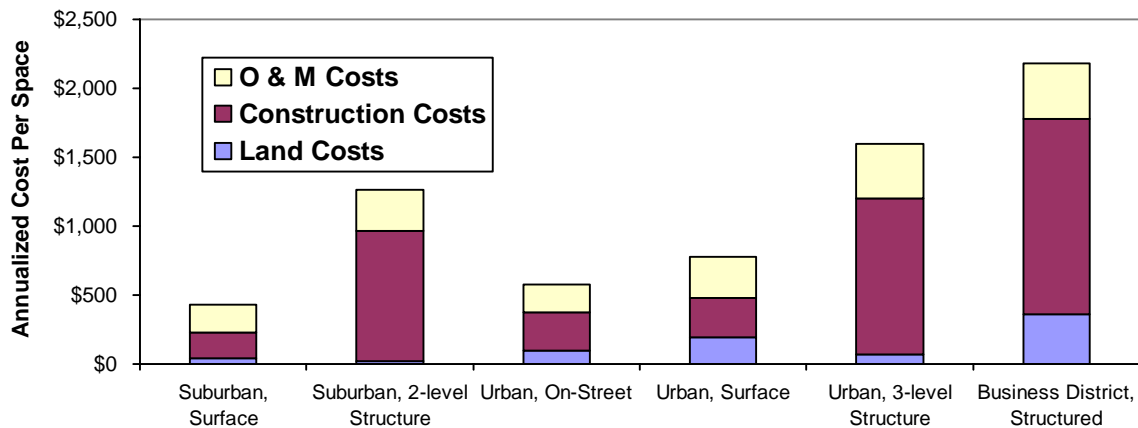
This table indicates optimal fees for the accident risk a vehicle imposes on other road users. Although a portion of these risks are compensated by insurance, vehicle insurance is a fixed rather than a variable charge, so the per-mile cost to motorists is virtually zero.

Parking Pricing

Optimal pricing requires that, as much as possible, motorists pay directly for using parking facilities. User fees should be sufficient to recover all parking facility construction and operating costs, including the equivalent of rent and taxes on land. Prices should vary with time and location to limit demand to about 85% maximum occupancy (Shoup, 2005). As much as possible parking should be *unbundled* (rented separately from building space, so for example, instead of paying \$1,000 per month for an apartment with two “free” parking spaces, residents pay \$800 monthly for the apartment and \$100 monthly per space), and if parking is subsidized it should be *cashing-out*, which means that consumers can choose the cash equivalent if they do not use it.

Figure 4 indicates typical costs of various types of parking facilities. Parking costs are estimated to average about \$600 annually per space, with two off-street spaces and two on-street spaces per vehicle (Litman, 2007a). This indicates that parking costs average about \$2,400 annually per vehicle-year or 20¢ per vehicle-mile. This is consistent with analysis by Delucchi (1996), who estimated that non-residential, off-street parking subsidies are worth \$148 to \$288 billion (in 1991 U.S. dollars), equivalent to \$1,200 to \$2,300 per vehicle-year or 10-20¢ per vehicle-mile in current dollars. Adding the value of residential and on-street parking, plus parking facility environmental costs would increase these estimates. Since on-street parking facilities are part of the roadway system, revenue from these spaces can be considered a roadway user fee.

Figure 4 Typical Parking Facility Annualized Costs per Space (Litman, 2007a)



This figure illustrates estimated annualized costs per parking space.

As described earlier, it may be infeasible to price all parking, including infrequently-used, unpaved suburban parking lots or rural road shoulders. Newer electronic pricing systems reduce transaction fees, allowing a greater portion of parking costs to be efficiently priced. Parking costs not recovered through direct user fees could be incorporated in distance-based fees. Such fees are suboptimal since they do not reflect the parking costs of individual trips, but are more efficient and fair than financing parking

facilities through general taxes, rents and retail prices unrelated to vehicle ownership or use.

Motorists currently park free at most destinations, and when priced, parking fees are often inefficient, failing to accurately reflect cost variations by time or location, and offering large discounts for longer-term passes (Shoup, 2005). I estimate here that currently on average U.S. motorists pay \$50 per vehicle-year for off-street parking, \$25 for on-street parking, and \$10 for unbundled residential parking overall.

The table below summarizes estimated optimal parking fees. Lower estimates assume the use of current pricing methods, which only allow about half of current parking subsidies to be efficiently priced or cashed out (since more valuable parking spaces are the best candidates to pricing, recovering 50% of parking subsidies should only require pricing 20-30% of currently unpriced spaces). The upper-bound estimate assumes universal implementation of vehicle location pricing systems that automatically calculate parking fees based on time and location. Currently only a small portion of residential parking is unbundling and priced. I estimate here that with optimal pricing, 10-30% of residential parking spaces would be priced at \$50 per month. Distance-based fees can recover parking costs not paid through direct user fees.

Table 6 Parking Fees Summary (Average Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Off-street parking	0.4¢	4.0¢	8.0¢	12.0¢
On-street parking	0.2¢	2.0¢	3.0¢	4.0¢
Residential parking unbundling	0.1¢	0.5¢	1.0¢	4.0¢
<i>Totals</i>	<i>0.7¢</i>	<i>6.5¢</i>	<i>12¢</i>	<i>20¢</i>

This table summarizes optimal parking fees. Although measured per vehicle-mile in this table, direct user fees would actually be priced per trip, or as monthly fees.

Emission Fees

Emission fees charge for air, noise and water pollution costs (Sevigny, 1998). Such fees give motorists incentives to reduce emissions to optimal levels. For example, emission fees give motorists extra incentive to minimize mileage of higher-polluting vehicles and for high annual mileage drivers to choose low-polluting vehicles. Ideally, such fees are calculated using in-vehicle meters that measure emissions as they occur, but this has high transaction costs. A less optimal but cheaper alternative is a per-mile charge based on average emission rates for each vehicle class, augmented with periodic vehicle testing and roadside sensors to identify gross polluters.

Various studies indicate that air pollution costs that range from about 0.5¢ per vehicle-mile for a low-emission vehicle driving in a rural area to more than 10¢ per mile for higher polluting vehicles driven in a vulnerable airshed (Vermeulen, et al, 2004; Delucchi, 1996; Litman, 2007a). Overall averages are within this range. Noise costs are estimated to average 0.2-2¢ per vehicle-mile, and are highly variable depending on vehicle type, time and location, and so require location-based pricing.

Table 7 Summary of Emission Fees (Average Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Air pollution	0.0¢	1.0¢	3.0¢	6¢
Noise pollution	0.0¢	0.0¢	0.5¢	1.0¢
Water pollution	0.0¢	0.0¢	0.5¢	1.0¢
<i>Totals</i>	<i>0.0¢</i>	<i>1.0¢</i>	<i>4.0¢</i>	<i>8.0¢</i>

This table summarizes optimal pollution fees. These should vary by vehicle type and location.

Fuel Taxes

Optimal transport pricing applies weight-distance fees rather than fuel taxes as road user fees. If this is done, fuel taxes need not include special road user costs, but they should incorporate petroleum production and importation externalities, carbon emission costs, and general sales tax. Since petroleum is a non-renewable resource, additional taxes may be applied to encourage conservation on sustainability grounds, to preserve more for future generations.

Petroleum production external costs (including environmental damages, tax subsidies, micro-economic and security costs of oil imports) are estimated to average \$0.30-1.00 per gallon (Delucchi, 1996; Litman, 2007a). Some of these costs require targeted taxes on specific impacts such as pollution emissions (to internalize environmental damages) and imports (to internalize macro-economic costs), which would result in some externalities being reduced. Because carbon emissions are proportional to fuel consumption, a fuel tax is an effective way of internalizing climate change emission costs, commonly called a *carbon tax*. Optimal carbon taxes are estimated to range from \$10-40 per ton of CO₂, equivalent to 10-40¢ per gallon of gasoline or 0.5-2.0¢ per vehicle-mile. Fuel is exempt from general sales tax in many states, representing a form of underpricing relative to other goods.

Current U.S. fuel taxes average about 40¢ per gallon, or about 2¢ per vehicle-mile (FHWA, 2005). Optimal fuel taxes are estimated here to average \$0.40 to \$1.00 per gallon or 2-5¢ per vehicle-mile to compensate for production externalities, importation economic costs, climate change emission costs and general sales tax, assuming that roadway and other pollution costs are internalized through other charges previously described. Incremental taxes per vehicle mile may be smaller if motorists respond by purchasing more fuel-efficient vehicles. Most of these taxes should be charged during the production and distribution process (such as environmental mitigation charges and import tariffs), rather than a single retail tax, which may reduce some of these external costs over the long term.

Table 8 Fuel Taxes (Average Per Vehicle-Mile)

	Current	Lower Bound	Middle	Upper Bound
Production & Import externalities	2.0¢	1.1¢	1.4¢	2.0¢
Climate change impacts	0.0¢	0.5¢	1.0¢	2.0¢
General sales taxes	0.2¢	0.4¢	0.6¢	1.0¢
<i>Totals</i>	2.2¢	2.0¢	3.0¢	5.0¢

This table summarizes optimal pollution fees. These should vary by vehicle type and location.

Optimal Pricing Summary

Table 9 various transportation costs and their appropriate pricing.

Table 9 Appropriate Pricing Of Various Transport Costs

Cost	Pricing Method	How Calculated
Congestion	Time and location based fee.	Price to reduce traffic volume to optimum flow.
Roadway costs	Weight-distance fee.	Cost allocation applied to all roadway costs, including traffic services and rent and taxes on roadway land.
Accidents	Time- and location-based fees, or distance-based fees.	Current insurance premiums prorated by annual mileage, increased to account for uncompensated accident costs.
Parking	Charge users directly for parking using time and location based fees.	Fees set to recover parking facility costs and maintain 85% maximum occupancy during peak periods.
Pollution Emissions	Time and location based fees (if possible) or distance-based fee.	A vehicle's emission rate (such as grams per mile) times regional pollution unit costs (such as cents per gram).
Fuel externalities	Fuel tax.	External costs of producing, importing and consuming fuel, including greenhouse gas emissions.
General taxes	General sales and property taxes.	General taxes should be applied in addition to any special vehicle and fuel taxes and fees.

This table describes the appropriate way to price various transport costs.

Table 10 summarizes middle-range values of these fees. These are averages; actual fees would vary depending on factors such as vehicle type, time and location.

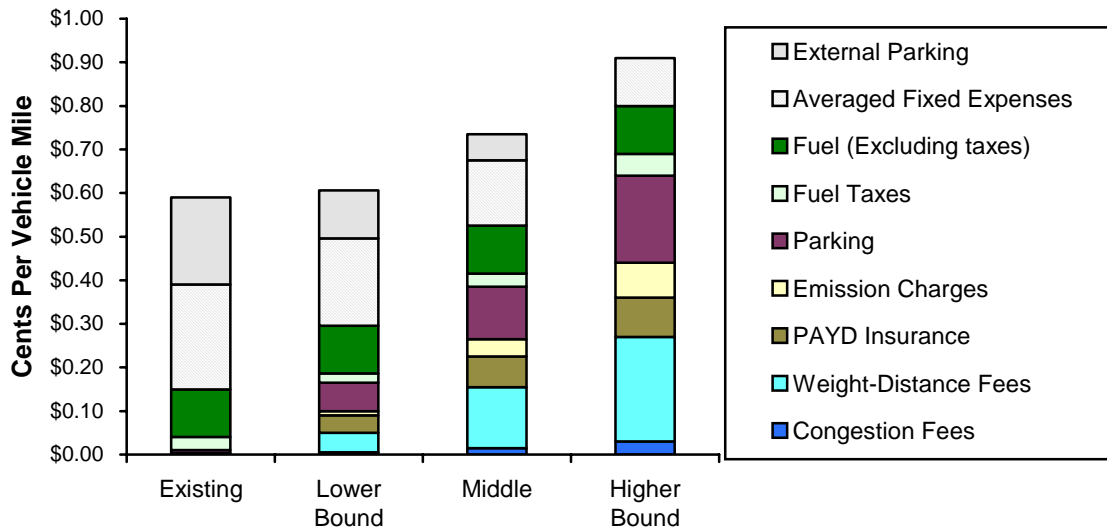
Table 10 Optimal Pricing Summary – Middle-Range Values (Average Per Vehicle-Mile)

Cost Category	Road Tolls	Weight-Distance	PAYD Insurance	Emission Charges	Parking	Fuel Taxes	Totals
Vehicle congestion	\$0.010						\$0.010
Nonmotorized delays	\$0.005						\$0.005
Roadway facilities		\$0.030					\$0.030
Registration & Licensing		\$0.020					\$0.020
Roadway land value		\$0.040					\$0.040
Traffic services		\$0.010					\$0.010
Land use impact costs		\$0.010					\$0.010
Accidents		\$0.030	\$0.070				\$0.100
Air pollution				\$0.030		\$0.010	\$0.040
Noise pollution				\$0.005			\$0.005
Water pollution				\$0.005			\$0.005
Parking facilities					\$0.120		\$0.120
Fuel externalities						\$0.014	\$0.014
General Taxes						\$0.006	\$0.006
<i>Total</i>	<i>\$0.015</i>	<i>\$0.140</i>	<i>\$0.070</i>	<i>\$0.040</i>	<i>\$0.120</i>	<i>\$0.030</i>	<i>\$0.415</i>
<i>Share of Total</i>	<i>3.6%</i>	<i>33.7%</i>	<i>16.9%</i>	<i>9.6%</i>	<i>28.9%</i>	<i>7.2%</i>	<i>100.0%</i>

This table summarizes the middle-range optimal fees estimated in this paper.

Figure 5 illustrates optimal fees. With current pricing motorists pay an average of about 25¢ per vehicle-mile in fixed expenses, about 11¢ per vehicle-mile for fuel, and only about 4¢ per vehicle-mile in variable user fees (fuel taxes, road tolls, parking fees and fines). More optimal pricing converts some currently fixed costs (insurance and registration fees) into distance-based charges and internalizes some currently external costs such as congestion, road and parking subsidies, and uncompensated accident costs. Using the middle cost estimates, this increases variable costs from about 15¢ to 50¢ per vehicle-mile, and reduces fixed costs from 24¢ to 15¢ per vehicle-mile.

Figure 5 Optimal Fees for an Average Automobile



This figure compares current and optimal vehicle user fees, as estimated in this report. With current pricing, motorists pay about 15¢ per vehicle-mile in variable costs and 24¢ in averaged fixed costs. More optimal pricing converts insurance and registration fees into variable charges, and internalizes a portion of currently external costs such as congestion, road and parking subsidies, and currently uncompensated crash risks.

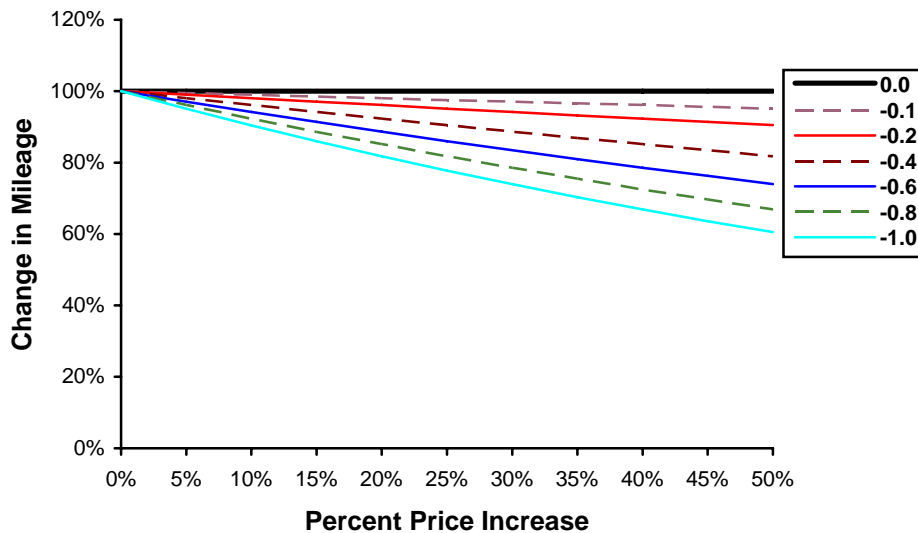
Optimal fees would provide substantial revenues. Some (such as road tolls and parking fees) would be dedicated to replacing current road and parking subsidies. Others (such as emission charges and fuel taxes) could be used to reduce taxes or finance new services. With optimal pricing an average consumer pays the same overall if they continue driving their current mileage and saves overall if they reduce their annual vehicle mileage or in other ways reduce costs, for example, by shifting vehicle travel from congested to uncongested times or by using less expensive parking facilities.

Travel Impacts

More efficient transportation pricing can cause various changes in travel behavior, including shifts in travel time (to avoid peak-period fees), route (to avoid priced roadways), mode (such as shifts from automobile to cycling, ridesharing or public transit), and destinations (such as from priced to unpriced areas). Efficient parking pricing may cause motorists to shift parking locations (such as parking at the edge of downtown where fees are lower). Efficient pricing can also affect demand for alternative modes, and so affect transport system diversity (such as improving walking, ridesharing and transit service quality), particularly over the long run. Similarly, it can affect land use patterns (such as creating more demand for transit-oriented locations).

Overall, the elasticity of vehicle travel with respect to operating costs is typically about -0.10 in the short-run and -0.30 over the long-run, so a 10% fee increase reduces vehicle travel about 1.0% within the first year, and about 3% after a few years, but there is considerable variation, depending on specific conditions (Litman, 2004a).

Figure 6 Mileage Changes From Price Increases for Various Elasticity Values



This figure indicates the travel reductions caused by price increases for various elasticity values.

Many specific factors can affect travel impacts, including the travel and destination options available (better options increases price sensitivity), demographics (lower income and physically fit people are more likely to shift modes), type of trip (travel with heavy loads is less price sensitive), how incentives are implemented, and the time period being considered (most impacts tend to increase over time).

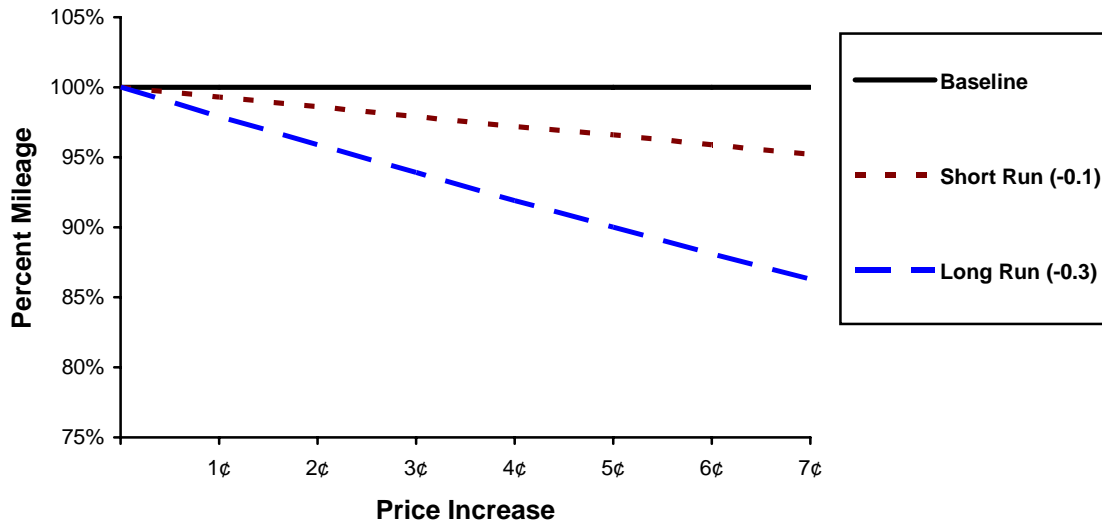
Large price changes have declining marginal impacts because they affect travel with higher consumer value. Arc elasticities reflect the change in consumption resulting from each 1% price change. This can be calculated as $[(1-e) \times (1-e) \times (1-e) \dots]$, or $(1-e)^n$ where e = elasticity and n = the percentage price change. Thus a 25% price increase with a -0.15 elasticity is calculated as $(1.0 - 0.15)^{25\%} = 0.85^{0.25} = 0.96 =$ a 4% net reduction.

Described differently, total price impacts are multiplicative not additive, because each additional factor applies to a smaller base. For example, if one factor reduces demand 10%, and a second factor reduces demand an additional 15%, their combined effect is calculated $90\% \times 85\% = 77\%$, a 23-point reduction, rather than adding $10\% + 15\% = 25\%$. This occurs because the 15% reduction applies to a base that is already reduced 10%.

Over the long-run consumers respond to higher fuel prices by purchasing more fuel efficient vehicles, which reduces long-run travel impacts. Per-mile fees (such as weight-distance fees and pay-as-you-drive insurance premiums) are unaffected in this way. Road tolls and parking fees tend to be particularly effective at reducing urban-peak travel.

Current vehicle operating costs average about 15¢ per vehicle-mile, so each additional 1¢ per-vehicle-mile represents a 7% price increase, which should reduce vehicle travel by about 0.7% over the short-run and 2% over the long-run, as illustrated in Figure 7.

Figure 7 Mileage Reduction From Price Increases



This figure indicates the travel reductions caused by price increases, based on 15¢ per vehicle-mile existing prices, and elasticities of -0.1 in the short run and -0.3 in the long run.

Table 11 estimates the reductions in total vehicle travel predicted for the middle-range price estimates, applying a -0.2 elasticity, which means that each 1¢ per mile increase in vehicle operating costs causes approximately a 1.4% reduction in vehicle travel.

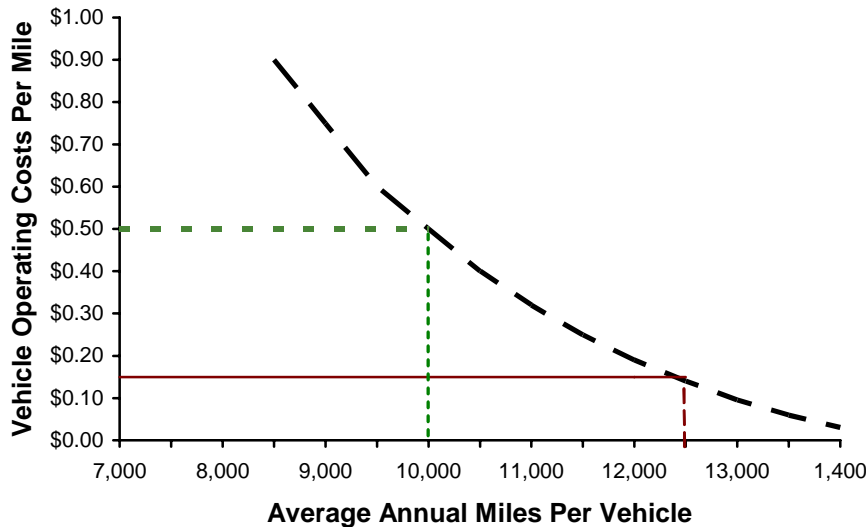
Table 11 Vehicle Travel Reductions – Middle-Range Cost Values

	Existing Fees	Optimal Fee	Fee Increase	Individual Reduction	Cumulative Reduction
Road Tolls	\$0.003	\$0.015	\$0.012	1.7%	1.73%
Weight-Distance	\$0.000	\$0.140	\$0.140	19.5%	20.87%
PAYD Insurance	\$0.000	\$0.070	\$0.070	9.7%	28.58%
Emission Charges	\$0.000	\$0.040	\$0.040	5.6%	32.56%
Parking	\$0.007	\$0.120	\$0.113	15.8%	43.18%
Fuel Taxes	\$0.030	\$0.030	\$0.000	0.1%	43.21%
Fuel prices (excluding taxes)	\$0.110	\$0.110	\$0.000	0.0%	43.21%
<i>Totals</i>	<i>\$0.149</i>	<i>\$0.525</i>	<i>\$0.376</i>		<i>43.21%</i>

This table summarizes optimal prices and their impacts on vehicle travel.

Figure 8 illustrates the vehicle travel demand curve, assuming lower-bound elasticity values. Current vehicle operating costs average about 15¢ per mile and motorists drive about 12,500 average annual miles. More optimal pricing would average about 50¢ per vehicle-mile, which should reduce vehicle travel 20% to 10,000 average annual miles. Savings and benefits should be proportionately larger since efficient pricing targets the highest cost travel. For example, congestion and parking fees tend to be largest under urban conditions where external costs (congestion, road, parking, accident risk and pollution costs) are particularly high. As a result, such fees might only reduce 20% of total vehicle travel but 40-60% of external vehicle costs.

Figure 8 Estimated Mileage Demand Curve



This figure illustrates the average annual vehicle mileage demand curve. Current vehicle operating costs average about 15¢ per mile, resulting in about 12,500 average annual miles. Optimal pricing would average about 50¢ per vehicle-mile, which would result in 20-40% reductions in average annual miles, assuming a -0.1 to -0.2 elasticity. Higher elasticity values would result in greater travel reductions for a given price increase.

Consumer Options – Efficient Planning

Consumer options (also called *consumer choice* and *consumer sovereignty*) means that consumers have an appropriate variety of goods and services from which to choose, and accurate information about their options. This lets consumers choose the combination of goods and services that best meet their needs. Transportation options can include:

- *Vehicles*, such as vehicle types (cars, trucks, hybrids, alternative fuels) and ownership options (purchased, leased, shared, etc.).
- *Modes*, such as walking, cycling, public transportation, telework and delivery services.
- *Roadways*, such as between free but congested lanes, HOV lanes, and priced lanes.
- *Parking*, such as allowing motorists to choose between more convenient but higher priced and cheaper but less convenient parking facilities.
- *Public transport services*, with various combinations of convenience, amenities and prices.
- *Land use and locations*, such as between automobile dependent and more multi-modal neighborhoods and destinations.

If consumers lack adequate transport options, the mobility patterns that result are not necessarily optimal. For example, high levels of automobile travel can only be considered optimal if consumers have viable alternatives. Some automobile users might actually prefer other modes (walking, cycling, ridesharing, public transit, telework) if they were available at an appropriate quality of service. This is not to say that every possible option must be available everywhere, but in general, consumers benefit from having more options. In an efficient market all cost-effective options should be available, including options that would be self-financing (user fees could cover costs), or are more cost effective than those that are subsidized, for example, if vanpool subsidies are more cost effective than expanding roads and parking facilities. Even options that are not cost effective in terms of economic returns may still be justified if they provide other benefits, such as equity, public health or enjoyment.

The current transportation system tends to be automobile oriented (also called *automobile dependent*), meaning that it offers good options for automobile travel (various vehicles, facilities and services), but limited alternatives. Walking and cycling conditions are often poor. Public transit services are often limited (in geographic coverage and frequency), inferior (in terms of convenience, comfort and security), and poorly integrated with other transport system components.

To the degree that automobile dependency results from planning distortions which limit the options and impacts considered by decision-makers, it is suboptimal (Litman, 2007b). For example, if planning analysis undervalues nonmotorized travel and exaggerates highway expansion benefits, or if transportation financing practices favor investments in road and parking facilities over more cost-effective mobility management programs, transport options will be inefficiently reduced.

Optimal Planning Principles

Countless individual policy and planning decisions, such as those listed below, affect the quantity and quality of travel options available in a particular situation, and the relative attractiveness of a particular travel mode or destination.

Policy and Planning Decisions That Affect Travel Options

- Transport funding
- Road and parking facility design
- Road space allocation
- Traffic regulations
- Taxes
- Public building location and design
- Public transport service quality
- Fares
- Zoning codes
- Land use density and mix
- Parking requirements
- Infrastructure pricing

An optimal transportation market requires planning that reflects the following principles:

- Comprehensive analysis that considers all impacts (benefits and costs) and options (including alternative modes and demand management strategies).
- Evaluation based on *accessibility* rather than *mobility*, so land use accessibility and mobility substitutes (such as delivery services and telecommunications that substitutes for physical travel) can be considered as well as mobility.
- Unbiased decision-making that does not arbitrarily favor certain modes of access, groups or activities. Policies favoring certain groups or goods that are justified to achieve equity or strategic objectives should be narrowly targeted to achieve their goals most efficiently and fairly.
- Explicitly recognizes the value of transport diversity, taking into account equity (accessibility for disadvantaged people), resilience (the value of having options available for dealing with diverse future conditions) and efficiency (increased transport diversity allows the most efficient mode to be used for each trip) objectives.

Even modest planning distortions can significantly impact transport options due to leverage effects, resulting in large, unintended consequences. Transportation is *co-produced* by governments (which supply roads and transit services, set parking policies, etc.), and individuals, who purchase and drive vehicles, pay fees, make location decisions and consume transport services. For example, a few million dollars spent on roads and parking facilities can leverage millions of additional vehicle-miles, adding billions of dollars worth of additional economic, social and environmental costs compared with the same resources invested in other types of accessibility improvements. Similarly, when public officials establish generous minimum parking requirements in zoning codes, they are probably not thinking about the reduced walkability, increased vehicle traffic or increased sprawl that will result – they are simply trying to find a convenient solution to a specific problem. Since most transport alternatives experience economies of scale, their quantity and quality tend to increase with increased demand. For example, if transit mode split increases from 2% to 6%, service coverage and frequency, passenger security and social acceptability will all tend to increase.

Transport planning tends to be biased in favor of faster and more costly modes over other accessibility options (Hallenbeck, et al, 2006; Litman, 2007b). Goodwin (2004) identified the following factors that contribute to this bias:

- The general dominance of increased travel speed as a planning goal.
- Undervaluation of travel comfort and security values.
- Underestimating generated traffic impacts, which exaggerates roadway expansion benefits.
- Exaggerated economic development benefits.

Examples of policy bias include dedicated highway funding sources and government agencies organized to deliver roadway improvements, with less funding and support for alternatives, particularly nonmotorized travel; the relatively poor connections between alternative travel modes, such as inadequate public transit terminals and waiting areas; generous minimum parking requirements incorporated in building codes; generous business tax deductions for vehicle use; and land use policies that encourage automobile-oriented development at the expense of other forms of access. Until recently, few federal, state or provincial transportation agencies had non-motorized transportation planning specialists, and few dedicate more than 1% of their budgets to non-motorized travel, although walking and cycling represent 5-15% of all trips (when correctly measured), are critical for public transit travel, and are heavily used by economically and physically disadvantaged populations and so are particularly important for achieving equity and economic development objectives.

Similarly, private companies often make decisions that favor automobile travel over other modes, including locating and designing offices to favor automobile access, and employee parking and vehicle travel subsidies with no comparable benefits for employees using other modes.

Planning bias favoring higher speed modes may result, in part, because the people who tend to be most influential in the planning process (planning professionals, public officials and their political supporters) tend to be busy, higher-income professionals who depend primarily on automobile transportation and seldom depend on alternative modes. As a result, they are likely to better understand and value automobile transport improvements over other types of transportation improvements. This results in various types of bias favoring automobile transportation.

The evaluation of transport problems and potential solutions generally focuses on motor vehicle traffic, assuming that all travelers (or at least, all travelers who count) have access to an automobile. The negative impacts that highway expansion would have on pedestrian travel, and the additional benefits of solving traffic problems by improving travel options and therefore improving mobility for non-drivers, is generally given less consideration.

Current Conditions

Current markets generally offer good options when purchasing motor vehicles and related services, but fewer alternative accessibility options, as summarized in Table 12.

Table 12 Transportation Options

Options	Current Conditions	Improved Options
Vehicles	Good options when purchasing or leasing an automobile, but few alternatives to owning a personal vehicle, and few pricing options.	Carsharing (affordable vehicle rental services). Pay-as-you-drive vehicle insurance and registration fees.
Modes.	Walking and cycling are often difficult and dangerous. Public transit services are often uncomfortable and inconvenient.	Improved walking and cycling conditions. Improved ridesharing and transit services. Telework. Delivery services (by retail stores).
Roadways	On most roadways all travelers face congestion, even rideshare and transit passengers who impose less congestion than SOV passengers.	HOV priority and congestion pricing lanes, so travelers can choose between slower-cheap-SOV travel, faster HOV travel, and priced SOV travel.
Parking	Parking is generally paid indirectly (bundled with building space) and unpriced. Commuters who receive subsidized parking are generally unable to choose an alternative benefit.	Unbundled parking. Pricing that allows users to choose between lower-priced but less convenient spaces, and higher-priced but more convenient spaces.
Public transport	Often uncomfortable and inconvenient to use.	More amenities, price and payment options that meet consumer demands.
Locations	Much new housing and businesses are located in automobile-dependent locations. Multi-modal neighborhoods (accessible by walking, cycling and public transit) are often undesirable.	More housing options, including various housing types (multi-family, townhouses, small-lot single-family) price ranges and neighborhood types (walkable, new urbanist, transit-oriented).

Although consumers have many options when purchasing motor vehicles and related services, they often have few alternative accessibility options.

Current planning and funding practices are biased in various ways that favor mobility over accessibility and automobile transport over other modes (Litman, 2006a). This results, in part, because mobility is easier to measure than accessibility, and motor vehicle traffic is easier to evaluate than alternative modes, such as the quality of walking conditions or transit travel convenience and comfort.

Most transport planning is performed by organizations that were originally *highway* agencies that have been renamed *transportation* agencies, but have yet to be fully reorganized to support multi-modal planning and mobility management programs (Sussman, 2001). Similarly, most resources (publications, software and training programs) produced by transportation professional organizations such as the Institute of Transportation Engineers and the Transportation Research Board focus on motor vehicle traffic conditions; although these organizations are now working to provide more balance (for example, providing more resources for nonmotorized transport, operational management programs, and smart growth planning), it will require many years to develop suitable materials and analysis tools.

Below are specific ways that current planning practices favor mobility over accessibility and automobile travel over other modes.

- Automobile and air travel are favored because they are considered modern and prestigious, while alternative modes receive less support because they are considered outdated and stigmatized.
- Commonly-used transportation performance indicators (such as roadway Level-of-Service ratings and average traffic speeds) reflect automobile travel conditions and overlook impacts on other forms of accessibility. This skews planning decisions to favor automobile-oriented improvements, even if this reduces walkability and transit efficiency, or stimulates sprawl.
- Transport statistics undercount and undervalue nonmotorized travel by ignoring short trips, off-peak trips, childrens’ travel, recreational travel, and nonmotorized links of motorized trips. For example, a *bike-transit-walk* trip is often classified simply as a *transit* trip, ignoring the cycling and walking links. This undervalues nonmotorized modes.
- A significant portion of transport funds are dedicated to roads, parking facilities and airports, and cannot be used for alternative modes or management programs even if they are more cost effective overall (CEE, 2007). Table 13 summarizes how current planning and funding practices favor highways over transit investments.

Table 13 Highway Vs. Transit Planning (Sussman, 2001; Beimborn and Puentes, 2003)

	Highways	Transit
Project Criteria and Justification	No cost effectiveness requirement.	Requires detailed cost effectiveness analysis and financial plan.
Federal Funding	U.S. federal match is 80-90%, depending on program. Most states have dedicated fuel tax and licensing revenues that make it easy to provide matching funds.	U.S. federal law allows up to 80% federal share, but FTA only recommends projects with maximum 60% federal share due to limited funding.
Land Use Impacts	Land use impacts of project not considered.	“Transit supportive land use patterns” a key project selection criterion.
Performance Evaluation	Peer comparison is rare. Alternative comparisons are optional at state level.	Peer comparison mandatory and reported to Congress. A detailed process is used to compare alternative projects.
Transparency	Planning analysis is difficult to access and unclear for the general public.	Planning analysis is publicly accessible and transparent.

Current planning and funding practices tend to favor highway over transit.

- Automobile transport costs are widely dispersed, including private costs (for vehicles), government costs (for roads) and business costs (for parking), while transit costs are concentrated in government-funded transit projects (which include vehicles, lines and terminals). This makes roadway projects appear more cost-effective than transit projects.
- Traffic models and traffic/parking generation manuals predict demand based on unpriced roads and parking facilities. This creates a self-fulfilling prophecy as planning decisions are made to satisfy unpriced demand and demand grows to fill the generous supply of underpriced roads and parking.

Socially Optimal Transport Prices and Markets

- In most communities only about 2-4% of government transport funds are spent on nonmotorized facilities (and only 1-2% of road and parking expenditures), although 5-10% of all trips, and 10-30% of all urban trips, involve walking or cycling on public facilities.
- Conventional planning focuses primarily on quantitative factors such as travel speed and price, and undervalues qualitative factors such as comfort and convenience (Litman, 2007c). This reduces the quality of walking, cycling and transit travel, while automobile travelers can purchase amenities such as more luxurious vehicles, which encourages travelers who demand high service quality to choose automobile transport.
- Alternative modes experience economies of scale (their quality tends to increase with use), but this is often ignored in evaluation, which undervalues policies that increase their use.
- Transport project evaluation generally considers a limited set of impacts, which tends to underestimate the full costs of increased vehicle travel and the full benefits of alternative modes and demand management, as summarized in Table 14. These practices tend to reduce support for alternative modes and for mobility management programs.

Table 14 Conventional Versus Comprehensive Evaluation (“Comprehensive Transport Planning,” VTPI, 2006)

Principle	Description	Conventional	Comprehensive
Perspective	Whether analysis is based on mobility or accessibility.	Mobility	Accessibility
Options Considered	Range of solutions considered, including various alternative modes and mobility management solutions.	Favors automobile-oriented options	Includes alt. modes and mobility mangt.
Planning Integration	Whether planning is coordinated among various levels of government, jurisdictions and sectors.	Weak coordination	Strong coordination
Financing Practices	How transport funds are allocated, and the flexibility with which it can be used for the best overall option.	Favors roadway investments	Applies least-cost planning
Definition of Demand	Whether planning assumes that all vehicle travel demand should be accommodated without constraint.	Tries to serve all potential demand	Manages demand for efficiency.
Modeling Practices	Whether transport modeling uses best practices for evaluating travel impacts and economic effects.	Generally limited	More comprehensive
Generated Traffic & Induced Travel	Whether planning accounts for generated traffic and induced travel.	Limited analysis	Comprehensive analysis
Service Quality	How well qualitative factors such as comfort and convenience are considered in transport planning.	Limited analysis	Comprehensive analysis
Downstream Congestion	Whether planning considers the additional surface street congestion resulting from expanded highways.	Ignores for individual projects	Considers this impact
Consumer Impacts	How impacts on consumers caused by changes in the transport system are evaluated.	Only considers travel time changes	Uses consumer surplus analysis
Parking Costs	Which parking costs are considered.	Few parking costs	All parking costs
Vehicle Costs	Which vehicle costs are considered (operating, mileage-based, ownership, residential parking).	Only operating costs	Comprehensive analysis
Construction Impacts	Whether construction period congestion delays are considered.	Ignores	Includes
Transportation Diversity	Whether value is assigned to transport diversity impacts (the value of having diverse mobility options).	Little or no consideration	Comprehensive
Equity Analysis	Whether value is assigned to equity impacts.	Limited analysis	Comprehensive

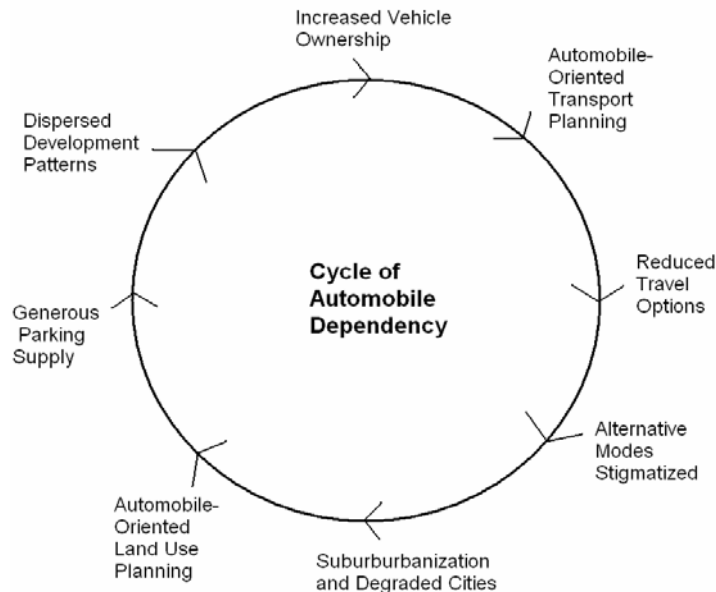
Environmental Impacts	Range and detail of environmental impacts considered in analysis.	Limited analysis	Comprehensive analysis
Land Use Impacts	Whether analysis considers impacts with regard to strategic land use objectives.	Limited analysis	Comprehensive analysis
Economic Development	How well economic development impacts are considered.	Limited and outdated analysis	Comprehensive, current analysis
Safety and Health Impacts	How safety and health risks are measured.	Per vehicle-mile crash risks	Per-capita health risks

Conventional evaluation tends to overlook many of the costs of increased automobile traffic and many of the benefits of alternative modes and mobility management strategies.

This analysis indicates that current transportation planning practices are biased in various ways that tend to favor mobility relative to other goods, and automobile transport over alternative modes such as walking, cycling, ridesharing and public transit. Many of these biases are subtle and individually modest, making automobile-oriented improvements appear marginally more cost-effective or easier to implement relative to alternatives.

Although individually these planning distortions may seem modest and reasonable, their impacts are cumulative and synergist (total impacts are greater than the sum of their individual impacts), particularly over the long-run, as automobile-oriented planning decisions contribute to a self-reinforcing cycle of increased automobile dependency and sprawled land use patterns as illustrated in Figure 9.

Figure 9 Cycle of Automobile Dependency and Sprawl



Biased planning practices contribute to a self-reinforcing cycle of increased automobile dependency and sprawl.

Some people claim that biases favoring automobile transportation are justified due to various benefits or to offset comparable biases favoring alternative modes (Dunn, 1998; O'Toole, 2006). These justifications are evaluated below. Biases favoring automobile transport may have been justified decades ago to achieve economies of scale in vehicle and roadway production, but once these systems are mature such biases are no longer justified, and policies favoring alternative modes are probably justified to achieve transport diversity benefits ("Evaluating Transportation Diversity," VTPI, 2006).

Evaluating Possible Justifications For Favoring Automobile Transport

(Litman, 2004b; "Evaluating Criticism of TDM," VTPI, 2006)

- *Argument:* Automobile travel is modern and efficient, with growing demand that should be accommodated. Alternative modes (walking, cycling, public transit) are outdated and inefficient, with declining demand.

Response: Per capita vehicle travel peaked about the year 2000. Demographic (aging population), economic (higher fuel costs) and shifts in consumer preferences (increased demand for urban living and active transport) favor alternative modes. Improving mobility options can efficiently address many transport problems (congestion, pollution, inaffordability, etc.).

- *Argument:* The large number of households that choose to live in suburban communities demonstrates consumer preference for automobile dependency.

Response: Market surveys indicate that many of the attributes that motivate consumers to choose suburban locations are features, such as security, good schools and newer building stock, rather than attributes directly dependent on automobile-dependency, that a significant and growing portion of suburban residents would prefer more accessible, multi-modal communities if they had these other attributes (Belden, Russonello and Stewart, 2004).

- *Argument:* Americans (or Germans, Italians, etc.) love their cars. They will not give it up.

Response: Automobile travel that people value will continue. Efficient pricing simply allows consumers to choose the amount of driving they really value.

- *Argument:* Public transit services receive an excessive share of transportation funding. For example, about 20% of total federal transport funds are spent on public transit services, although less than 2% of total trips are made by transit. Critics consider this wasteful and unfair.

Response: There are several reasons that transit receives relatively large subsidies:

- A significant portion of subsidies (about half) are intended to provide basic mobility for non-drivers. This requires service at times and locations with low demand, and costly special services to accommodate people with disabilities, such as wheelchair lifts.
- A significant portion of transit service is provided in dense urban areas where any form of mobility is costly to provide, so urban transit costs should be compared with the cost of accommodating additional automobile travel under comparable conditions.
- Transit project costs include vehicles, lines (rail or busways) and terminals, so transit project costs should be compared with combined vehicle, roadway and parking costs.
- During most of the last half-century transit received relatively little investment. Significant new funding can be justified to catch up with decades of underfunding.

Planning Reforms

This analysis indicates that current planning practices are biased in ways that favor automobile-oriented transportation, and that more objective and comprehensive planning would favor more multi-modal planning and more accessible land use policies. A variety of specific planning and funding reforms can correct existing biases that reduce transport options. *Least-cost planning* (VTPI, 2006) refers to planning and investment practices that current existing biases favoring automobile transport by:

- Considering all economic impacts including indirect impacts such as user costs, parking, congestion, accidents, and pollution.
- Considering demand management options (such as congestion pricing and programs to promote use of alternative modes) equally with facility capacity expansion options.
- Providing funding to the most cost-effective solution, including demand management strategies and alternative modes.

To the degree that past planning distortions reduced transport diversity below what is optimal, there is justification for special policies and programs to improve options. Special efforts are probably justified to improve walking, cycling, ridesharing, public transit, carsharing and taxi services, on both efficiency and equity grounds, to correct decades of planning practices favoring automobile transport. For example, if nonmotorized modes received only 5% of transport funding, and comprehensive analysis indicates that 10% is optimal, it may be appropriate to devote 15% of transport funding to these modes for several years to correct the investment deficit.

It may be difficult to determine exactly what set of options is optimal in a particular situation. There is little reason to maintain options for which there is little demand (for example, cycling facilities or transit services that attract few users), but it does make sense to give alternative modes at least as much support per trip or per user as automobile modes, and often more in order to provide basic mobility, for equity sake, and to help achieve strategic objectives. For example, if society spends a total of \$5.00 on roads, parking facilities and traffic services for an automobile commute trip, it should be willing to devote at least that much for a commute trip by alternative modes such as walking, cycling or public transit, and often, more to support equity objectives (to provide basic mobility to disadvantaged people who cannot drive an automobile), to achieve economies of scale (increased use of these modes reduces their unit costs, allowing them to expand and improve), and to achieve strategic planning objectives, such as urban redevelopment.

Travel Impacts

These planning reforms would improve travel options and support mobility management programs. Transport modeling in various U.S. metropolitan regions summarized by Johnston (2006) indicates that more optimal regional transport planning and investment practices, selected to maximize cost efficiency and consumer surplus, would reduce VMT by 10% to 20% compared to trend scenarios, while supporting the same level of job and housing growth, and providing comparable or better highway levels-of-service. The optimized plans include pricing reforms (such as road and parking pricing), increase investment in alternative modes (such as busways and rail transit services), and land use policies that improve accessibility (such as more compact and transit-oriented development). Additional VMT reductions could be expected if such reforms were also applied to local transport planning practices.

Various case studies also indicate that more efficient and neutral planning tends to increase travel options and reduce automobile travel. Cost-effective strategies (unit costs are equal or less than that of accommodating additional automobile travel) that rely primarily on positive incentives (improved travel options and new financial rewards for those who reduce driving, but travelers who continue driving are not significantly worse) can reduce automobile trips by 10-30%. For example (“Success Stories,” VTPI, 2006):

- *Transit service improvements and commute trip reduction programs* reduced drive-alone commute rates in downtown Bellevue, Washington from 81% in 1990 to 57% in 2000, and in downtown Boulder from 56% in 1995 to 36% in 2005, and more than doubled transit mode share from 15% to 34%.
- *Individualized marketing programs*, which offer residents detailed travel option information have reduced automobile travel by 5-15% in various communities.
- Households that shift from private car ownership to *carsharing* typically reduce their annual vehicle mileage by 20-60%.
- *Campus transport management programs* with parking management and transit discounts often reduce student automobile trips by 10-20%.
- Tax policy reforms that reduce incentives for businesses to provide company cars and generous mileage allowances could reduce both business and personal travel. One study estimates that such reforms could reduce 2.4% of UK car mileage (IEEP, 1999).

People who live or work in areas with good mobility options tend to drive 10-30% less than national averages (“Land Use Impacts on Transport,” VTPI, 2006). Market surveys indicate that for various reasons (aging population, increased urbanization, health concerns, and rising future energy costs) demand for alternative modes and multi-modal locations is growing (Reconnecting America, 2004). This suggests that comprehensive, least-cost transport planning would significantly improve travel options and reduce automobile travel by at least 10%, and significantly more if implemented with additional pricing and land use reforms.

Land Use Markets

Land use patterns significantly affect mobility. For example, dispersed, automobile-oriented land use patterns require a high level of mobility to reach destinations and offer few travel options, and so increase automobile use. Conversely, more accessible and multi-modal land use patterns reduce the amount of mobility required to reach destinations and so tend to reduce per capita vehicle travel. As a result, land use market distortions that increase sprawl can lead to economically excessive motor vehicle travel, that is, more mobility than consumers would choose if land use policies were more efficient and neutral.

Until the 1950's, most communities were designed for multi-modalism, with compact development, well-connected street networks, sidewalks, and mixed land use that located commonly-used public services (shops, elementary schools, post offices, etc.) within convenient walking distance of homes, and commercial activities concentrated into downtown areas well served by public transit. Since then land use patterns have become more automobile-dependent, with lower densities, less connected streets and few sidewalks. A number of factors contributed to this shift, including abundant highway funding, zoning codes that restrict development density and mix, and a perception that suburban living is healthier, safer and more prestigious. However, it is uncertain that consumers really prefer automobile-dependency – market studies indicate that many households choose suburban locations for the sake of security, quality schools and prestige, and would actually prefer more multi-modal communities, provided that they had features such as good schools, safety and prestige (Belden, Russonello and Stewart, 2004; Reconnecting America, 2004; SmartTraq, 2006). To the degree that policies and development practices unintentionally favor automobile dependent development patterns, they are market distortions that increase mobility while reducing consumer welfare.

Described differently, current transport planning practices tend to favor *mobility* (physical movement) over *accessibility* (people's ability to reach desired goods, services and activities), and so ignore and undervalue strategies that increase land use accessibility such as more compact and mix development, more connected streets (Litman, 2003). For example, transportation agencies often impose minimum street widths and parking supply standards to facilitate automobile access, but seldom apply standards for minimum street and path connectivity, or maximum distances between homes, shops and schools to facilitate non-automobile access. Since these approaches often conflict (for example, a store or school located for convenient automobile access tends to be inconvenient for pedestrian access, and vice versa), this bias significantly stimulates sprawl and automobile dependency. Defining transportation in terms of accessibility expands the range of possible solutions that can be applied, which would increase the support available for smart growth land use development practices.

Current Distortions

Many current land use policies and planning practices unintentionally increase sprawl and automobile dependency (Lewyn, 2005 and 2006; Levine, 2006):

- Zoning codes and development polices often limit development density and mix, and require generous parking supply, leading to dispersed, automobile-oriented development.
- Taxes and utility rates fail to reflect the savings that result from more compact, accessible development, encouraging more dispersed development.
- Current public investment practices tend to favor infrastructure in new, greenfield locations over redevelopment of existing infrastructure.
- Lending policies treat household automobile ownership as an asset, rather than a liability, and ignore the financial savings that result from location-efficient housing (“Location Efficient Mortgages,” VTPI, 2006).
- Failure to efficiently price road space, and resulting attempts to reduce traffic congestion by continually increasing road space, compounded by dedicated highway capital funding, leads to economically excessive highway development.
- For many years urban communities were stigmatized. This resulted in a self-fulfilling prophecy, as middle-class people move from cities to suburbs, leaving cities with concentrated social problems.
- Transportation agencies generally lack incentives to reduce land requirements by sharing rights of way with other utilities (Feitelson and Papay, 1999). Land requirements can often be reduced by more coordinated planning and incentives for right-of-way sharing.

Potential Reforms

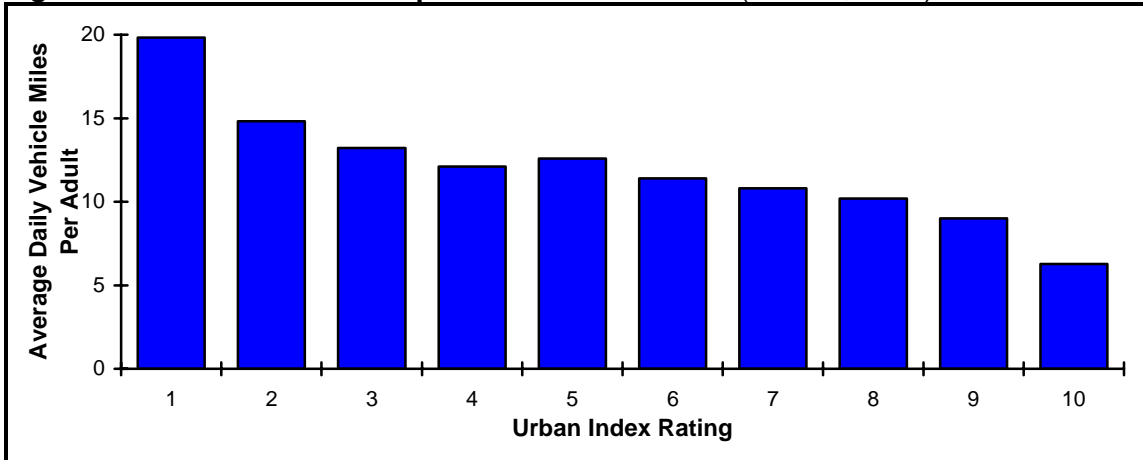
A variety of public policy reforms which reflect market principles can create more accessible, multi-modal land use development (“Smart Growth Reforms,” VTPI, 2006):

- Change zoning laws to allow higher densities, more land use mix, and more flexible parking requirements.
- Price utilities and fees to reflect higher costs of providing public services to lower-density, dispersed locations, and the public savings that result from more compact, infill locations.
- Use public infrastructure investments to favor infill development and suburban areas targeted for compact, multi-modal development, including improvements to urban roadways, schools, parks, utility lines, and locating new public facilities within existing urban areas or smart growth locations.
- Support location efficient mortgages, which recognize the potential transportation cost savings that households can achieve by choosing more accessible, multi-modal housing locations, and therefore their ability to meet higher mortgage payments.
- Use more neutral transportation planning practices to allow more investments in alternative modes and mobility management programs in urban areas.
- Support redevelopment of blighted urban areas through a combination of improved public services and promotion of the benefits of urban living.

Travel Impacts

Households located in compact, multi-modal locations tend to drive significantly less and rely more on alternative modes than comparable households located in automobile-oriented communities (USEPA, 2002; Ewing and Cervero, 2002; Litman, 2005). Figure 10 illustrates how land use density, mix, and street connectivity affect vehicle travel. A 10% increase in the Urban Index Rating reduces vehicle travel per adult an average of 7%. Other studies find similar impacts (CCAP, 2003).

Figure 10 Urbanization Impact On Vehicle Travel (Lawton, 2001)



Each 10% Urban Index Rating increase reduces vehicle travel per adult by 7% on average. The Urban Index reflects population density, land use mix and street connectivity.

It is difficult to predict exactly how consumers would respond to land use market reforms. As described earlier, there is evidence that many households would prefer less automobile dependent neighborhoods than what they currently experience, for example, neighborhoods where they could walk to stores and their children could walk to schools and parks, and market reforms described in this report would increase this by making smart growth communities more available, affordable and attractive.

These market reforms are unlikely to cause many people to shift from low-density suburbs to high-density urban locations, but they probably would cause incremental shifts, for example, from suburban large-lot, single-family, to clustered, small-lot single-family; from small-lot single-family to town-house; and from townhouse to condominium. Such incremental shifts typically reduce per-capita vehicle travel 5-15%. Similarly, shifting employment locations from automobile-dependent locations to more multi-modal commercial centers typically reduces automobile commuting 10-20%, by supporting ridesharing and public transit use, and giving employees pedestrian access to nearby services. It is therefore reasonable to think that market-based land use reforms would reduce automobile travel by 5-15% compared with current land used policies that favor automobile dependency and sprawl.

The table below summarizes market requirements, distortions, reforms and their travel impacts. Some overlap. For example, biased tax policies encourage businesses to offer employee parking subsidies, which underprices driving and reduces transport options.

Table 15 Market Principles, Distortions and Reforms

Market Requirements	Current Distortions	Reforms	Travel Impacts
<i>Efficient pricing.</i> Prices should reflect production costs unless a subsidy is specifically justified.	Transport in general, and driving in particular, is underpriced. Many costs are either fixed or external.	Charge directly for roads and parking, distance-based insurance and registration fees and emissions.	Efficient pricing is estimated to reduce automobile travel 20-40%.
<i>Transport options.</i> Consumers need viable transportation and location choices.	In many communities non-automobile travel options are inconvenient, uncomfortable and poorly integrated.	Apply least-cost planning. Improve alternative modes, connection between mode, and information about those options.	Least-cost planning and related reforms are estimated to reduce automobile travel 10-30%.
<i>Optimal Planning.</i> Policies and planning practices should not arbitrarily favor certain goods or groups.	Many public policies (taxes, regulations, etc.) and planning practices favor motor vehicle travel over alternatives.	Apply more neutral policies and <i>least-cost</i> transport planning practices.	More neutral policies and planning practices are estimated to reduce automobile travel 5-10.
<i>Land Use.</i> Land use policies should not favor automobile oriented development.	Many planning practices, zoning codes, utility pricing and tax structures encourage lower-density land use patterns.	Reform planning practices and pricing that unjustifiably encourage sprawl and automobile dependency.	Incremental shifts toward more multi-modal communities tend to reduce per-capita vehicle travel by 5-15%.

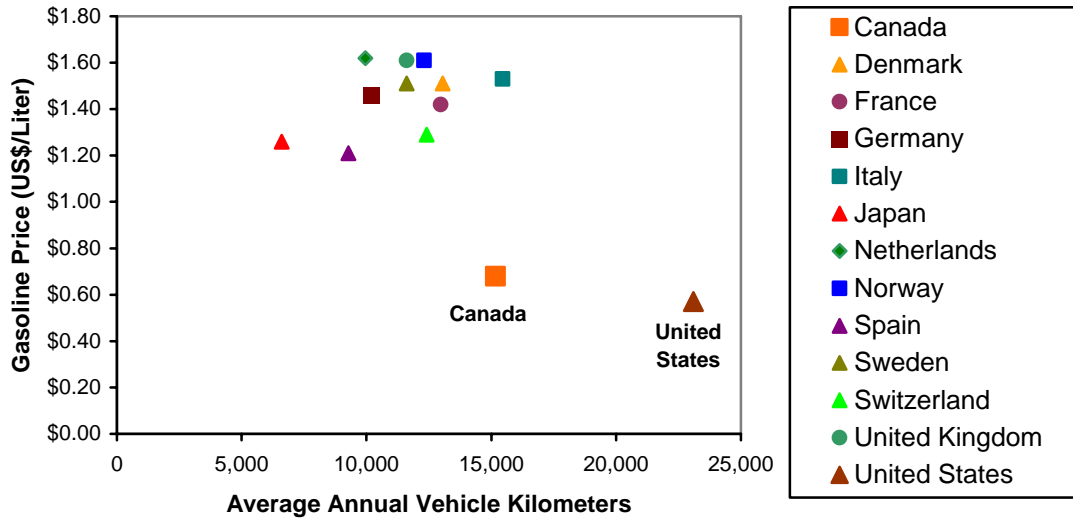
This table summarizes optimal market requirements, common distortions, reforms and their travel impacts.

These reforms have interactive effects, so their impacts cannot simply be added. On one hand, marginal effects tend to decline as more reforms are implemented. It is therefore wrong to assume, for example, that because a 1¢ per vehicle-mile fee reduces vehicle travel 1.4%, a 10¢ per vehicle-mile fee will reduce vehicle travel 14%. By themselves, large price increases tend to have diminishing marginal effects. On the other hand, many reforms have synergistic effects (total impacts are greater than the sum of individual impacts). For example, individually, a rideshare program and a parking cash out policy might each only reduce automobile commuting by 10%, but together they can provide a 30% reduction by both improving services and increasing incentives. Long-term synergistic impacts tend to be particularly large as transportation and land use patterns shift.

This analysis suggest that in a more optimal market, with efficient pricing, improved consumer options and more neutral public policies, people would drive significantly less, use alternative modes more, and be better off overall as a result. Comprehensive pricing reforms are likely to reduce automobile travel by 20-40%, improving travel options could reduce automobile travel by 10-20%, and land use reforms are likely to cause typical households to shift to home locations that reduce automobile travel by 5-15%.

The reasonableness of these estimates can be tested by comparing travel patterns in peer countries. According to OECD statistics, U.S. residents average 23,095 annual vehicle-kilometers, compared with about 10,000 to 15,000 in Canada and Western European countries. These differences result from the higher vehicle operating costs due to higher fuel taxes, more road tolls and parking fees, more investment in alternative modes, and more accessible land use patterns. Figure 11 compares annual pre capita vehicle kilometers and fuel prices in various countries. Even these countries do not apply all of the optimal transportation market reforms, such as pay-as-you-drive insurance and registration fees, so even greater reductions are likely to occur if all countries implemented all justified transport market reforms.

Figure 11 Vehicle Mileage Versus Fuel Prices (OECD, 2005; GTZ, 2005)



Most wealthy countries have fuel prices 100-150% higher and per capita annual vehicle mileage 40-60% lower than in the U.S.

Estimated Savings and Benefits

A more optimal transportation market would significantly reduce costs. The table below summarizes projected impacts and savings, using the unit costs illustrated in Figure 2. This assumes that market reforms reduce per capita vehicle ownership and therefore residential parking costs by 10%, and reduce annual mileage per vehicle by 28% with proportional reductions in most costs, with extra large reductions (twice proportionate) in congestion and environmental costs because congestion and emission pricing are particularly effective at reducing these costs (for example, although per capita vehicle mileage is projected to decline 36%, congestion costs are projected to decline 68%, since optimal pricing and planning should reduce the most congested vehicle-miles of travel).

Table 16 Estimated Optimal Pricing Impacts and Savings

Factors	Unit Costs	Current	Optimal	Difference	Percent
Vehicles Per Capita		0.80	0.72	0.08	-10%
Mileage Per Vehicle		12,396	8,870	3,526	-28%
Mileage Per Capita		9,874	6,359	3,515	-36%
Costs	Per Veh.-Mile	Person-Year	Person-Year	Person-Year	Person-Year
Vehicle Ownership	\$0.30	\$2,390	\$2,151	\$239	10%
Crash Damages	\$0.18	\$1,777	\$1,145	\$633	36%
Non-res. Parking	\$0.12	\$1,185	\$763	\$422	36%
Vehicle Operation	\$0.15	\$1,481	\$954	\$527	36%
Roadway Costs	\$0.05	\$494	\$318	\$176	36%
Traffic Congestion	\$0.04	\$395	\$127	\$268	68%
Environmental Costs	\$0.04	\$395	\$127	\$268	68%
Roadway Land Value	\$0.02	\$197	\$127	\$70	36%
Residential Parking	\$0.08	\$478	\$430	\$48	10%
Fuel Externalities	\$0.02	\$197	\$127	\$70	36%
Traffic Services	\$0.01	\$99	\$64	\$35	36%
<i>Totals</i>		\$9,088	\$6,333	\$2,756	30%

Using middle-range values, this analysis indicates that shifting from current to optimal pricing and planning would reduce vehicle ownership about 10%, mileage per vehicle about 28%, and per capita transportation costs about 30%.

Described differently, current pricing and market distortions increase average transport costs \$2,756 annual per capita. About a quarter of these are non-market costs, but these have economic value, such as crash disabilities that reduce incomes and environmental degradation that reduces property values and human health. Some costs are excluded because they are relatively difficult to measure, such as reduced mobility for non-drivers and the economic costs of sprawl, so total costs are probably somewhat larger, indicating even greater potential benefits from market reforms.

This indicates that optimal pricing would increase operating costs from 15¢ to 53¢ per vehicle-mile and reduce annual vehicle travel 3,515 miles per capita. Applying the rule-of-half (described on the next page), this reduction would reduce average consumer surplus \$661 per capita, for a \$2,095 net annual gain (\$2,756 - \$661 = \$2,095).

Explanation of the “Rule of Half”

Economic theory suggests that when consumers change travel patterns in response to a financial incentive, the net consumer surplus is half of their price change (called the “rule of half”). This takes into account total changes in financial costs and mobility as perceived by consumers.

Let’s say that the price of driving (perceived variable costs, or *vehicle operating costs*) increased by 10¢ per mile, either because of an additional fee (e.g., paid parking) or a financial reward, and as a result you reduce annual vehicle travel by 1,000 miles. You would not give up highly valuable vehicle travel, but there are probably some vehicle-miles that you would reduce, either by shifting to other modes, choosing closer destinations, or because the trip itself does not seem particularly important.

These vehicle-miles foregone have an incremental value to you, the consumer, between 0¢ and 10¢. If you consider the additional mile worth less than 0¢ (it has no value), you would not take it in the first place. If you consider it worth 1-9¢, a 10¢ per mile incentive will convince you to give it up – you’d rather have the money. If the additional mile is worth more than 10¢ per mile, a 10¢ per mile incentive is inadequate to convince you to give it up – you’ll keep driving. Of the 1,000 miles foregone, we can assume that the average net consumer benefit (called *consumer surplus*) is the mid-point of this range, that is, 5¢ per vehicle-mile. Thus, we can calculate that miles foregone by a 10¢ per vehicle-mile financial incentive have an average consumer surplus value of 5¢. Similarly, a \$100 increase in vehicle operating costs that reduces vehicle travel by 1,000 miles imposes *net consumer costs* of \$50, while a \$100 financial reward that reduces 1,000 vehicle-miles provides *net consumer benefits* of \$50.

Some people complicate this analysis by trying to track changes in consumer travel time, convenience and vehicle operating costs, but that is unnecessary. All we need to know to determine net consumer benefits and costs is the perceived change in price, either positive or negative, and the resulting change in consumption. This incorporates all the trade-offs consumers make between money, time and mobility.

Wealthy societies can afford these costs, but they are an economic burden to consumers and the economy. The average U.S. household earned \$58,712 in 2005, or \$23,484 per capita (BLS, 2007). The additional costs of transport market distortions therefore represent about 12% gross (\$2,756/\$23,484) or 9% net (\$2,095/\$23,484). These costs can be considered acceptable to wealthy consumers who value mobility and would expect to continue their current travel behaviour even with improved travel options and higher user fees. On the other hand, these costs are significant, reducing net wealth and opportunities for economic development. The additional costs tend to be particularly burdensome for lower-income households, which are often forced to choose between devoting a major share of their total expenditures to transportation, or to live without an automobile and so be mobility disadvantaged.

Described more positively, transportation market reforms that reduce total transportation costs and improve accessibility options can provide substantial savings and benefits to consumers and the economy. The \$5,000 average annual economic savings could allow many households to afford additional education, home purchases and retirement savings.

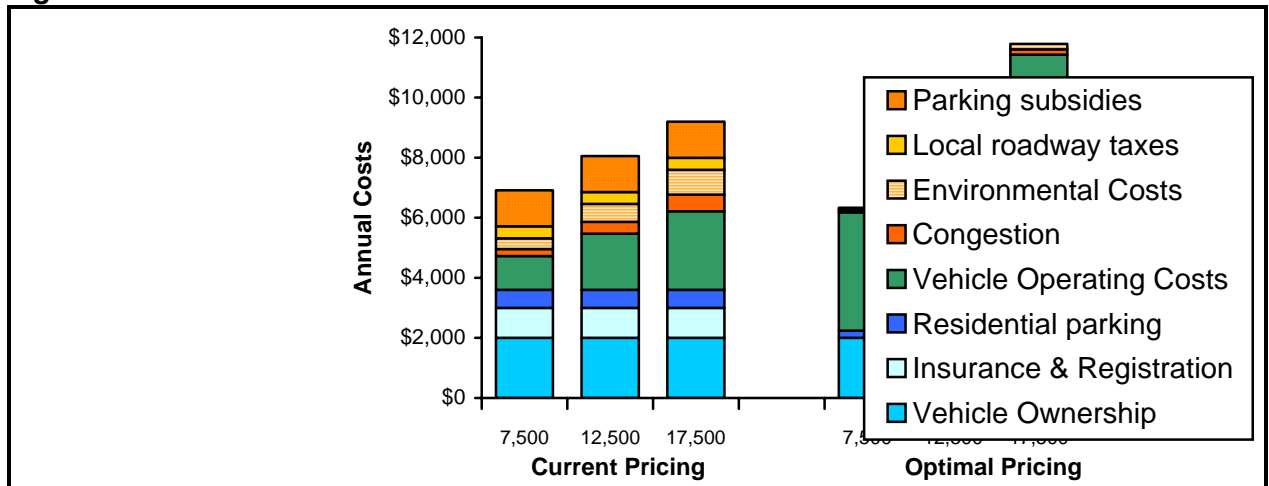
Consumer Impacts

It may seem counterintuitive that consumers would benefit from reforms that increase their vehicle operating costs and reduce their mobility. However, consumers would enjoy the following offsetting benefits and savings:

- Reduced traffic and parking congestion. Efficient pricing increases efficiency by allowing higher-value trips to outbid lower-value trips.
- Reduced accident risk and pollution exposure.
- Lower taxes, building costs and retail prices due to reduced road and parking subsidies.
- Improved transport and land use options, including better walking and cycling conditions, improved ridesharing and public transit services, and better integration among modes.
- More accessible land use patterns, reducing travel distances and improving travel options.
- Reduced chauffeuring responsibilities for drivers, due to better travel options for non-drivers.
- Improved security, prestige and public support of alternative modes.

Figure 12 illustrates the economic impacts of optimal transport pricing. With current pricing, most costs are either fixed or external. Efficient pricing converts more cost to internal-variable. Consumers who drive less than average would save overall. Those who drive current average annual mileage would experience little financial change (except any additional transaction costs), since their increased vehicle operating costs would be offset by savings. People who drive more than average would pay more overall. Since most motorists are expected to reduce their mileage, most people should save overall, and higher-mileage motorists would gain the most from reduced congestion, pollution and crash costs, and from increased travel options.

Figure 12 Costs Per Vehicle



With current pricing a major share of costs are fixed (blue) or external (orange). Optimal pricing converts these to variable costs (green), which increases the savings motorists receive for reducing mileage.

These price reforms would provide net savings to society since most cost increases are economic transfers (costs shifted from one person to another), while most cost reductions are true resource cost savings, resulting from reduced congestion, facility costs, crashes and environmental damages that result from reduced vehicle travel.

Because some pricing reforms increase taxes (such as additional road user fees to pay the equivalent of rent and taxes on roadway land, and emission fees based on a vehicle's pollution emissions), the overall benefits depend on how revenues are used. If used efficiently to reduce other taxes or provide additional beneficial services they can provide significant net benefits (called a *double dividend*, since they increase transport system efficiency and provide revenue). However, wasteful use of revenues reduces market reform net benefits. Although economic efficiency does not *require* that revenues be dedicated to transportation improvements, more optimal planning would tend to justify spending a portion of revenues on improving travel options, which should reduce the cost to consumers of changing modes and the price that must be charged to achieve a given reduction in transport costs (Litman, 1996).

Underpricing is horizontally inequitable, since it means that some people benefit at other's expense. Even if all households owned motor vehicles, there are still inequitable cross subsidies to the degree that some drive more and impose greater costs than others. Since automobile use increases with income, underpricing tends to be regressive, shifting resources from lower- to high-income households. It increases costs on other goods, particularly housing and reduces travel choices, both of which are harmful to disadvantaged populations. Although lower income households that own vehicles also benefit from underpricing, they benefit less than if the same subsidy were available for other goods and services. Optimal pricing should increase horizontal equity, particularly if revenue is used progressively and if travel choices increase.

Although few motorists want to give up driving altogether, at the margin, (compared with their current travel patterns), there are indications that many would probably prefer to spend somewhat less time driving and more time using other forms of access, provided that they are convenient, comfortable, safe, affordable and prestigious. Studies indicate that reducing daily driving reduces stress, improves fitness and health, and increases satisfaction with life (SMARTRAQ, 2007). Market surveys indicate that many households would prefer living in more accessible, multi-modal communities, where residents drive less and rely more on walking, cycling and public transport (Reconnecting America, 2004).

Economic Development Impacts

Because the vehicle-related industries are major industrial sectors people sometimes assume that reduced driving would reduce economic development (productivity, employment, income, wealth, property values, tax revenue, etc.). However, market reforms that increase economic efficiency should increase overall productivity and employment. These reforms would reduce consumer and businesses costs, including congestion delays, parking subsidies, crash damages, and general taxes. Many would also benefit from improved travel options, more accessible land use, and efficiencies of agglomeration. Freight efficiency should increase. High-value, time-sensitive freight would benefit from reduced congestion delays. Some freight would probably shift from truck to rail and ship. Since heavy trucks pay less than their roadway costs this will reduce public costs and increase productivity. Because rail and marine services experience scale economies (increased demand allows shippers to run more trains and ships, serve more destinations, upgrade more terminals, and in other ways improve service), such a shift could provide additional economic benefits.

Expenditures on vehicles and fuel provide less domestic employment and business profits than most other types of consumer purchases. For example, each 1% of regional travel shifted from automobile to transit in San Antonio, Texas increases regional income by \$2.9 million (about 5¢ per mile shifted), resulting in 226 additional regional jobs (Table 17). The automobile industry is now overcapitalized and unprofitable, and much of the input in most vehicles (including American brands) is imported. Fuel expenditures are particularly harmful to the economy by increasing trade deficits.

Table 17 Economic Impacts of \$1 Million Expenditure (Miller, Robison and Lahr, 1999)

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 the regional economic impacts of \$1 million consumer expenditure in Texas.

Most economic benefits claimed from underpricing vehicle use, such as increased employment in vehicle and bulk transport industries, are really economic transfers, in which one industry benefits at other's expense. Optimal pricing increases overall economic productivity and development, as consumers shift expenditures to goods with more local labor input, and due to overall increases in economic efficiency. Transition costs can be minimized by making price changes predictable and gradual, and by planning that anticipates impacts on demand and employment.

This is not to say that mobility and dispersed land use patterns provide no benefits to users and society. However, these benefits are offset by additional costs to society. An optimal market maximizes total benefits to society by encouraging individual consumers to use resources more efficiently.

Additional Factors

Some additional perspectives further support transportation market reforms.

First, transportation activities often experience *economic traps*, (also called *social traps*), which are situations in which individuals compete in ways that waste resources. Below are some examples:

- Individuals often gain speed, convenience and comfort by shifting from bus to automobile travel, but in doing so they increase traffic congestion for all road users and reduce demand for transit services.
- Consumers often compete for status by owning more valuable vehicles larger lot homes. This forces their peers to purchase equally costly vehicles and homes in order to maintain their social position. To the degree that people choose these for the sake of prestige rather than any functional benefits, the increased consumption provides no net benefit to society.
- People compete for rural ambiance (quiet, privacy and undeveloped views) by choosing urban fringe locations, but in doing so they impose traffic impacts on closer neighborhoods, which continually expands the distance that residents must travel to achieve rural living.

As a result of these traps it is possible to significantly increase mobility with little or no increase in overall social welfare. This helps explain, for example, why increased travel speeds often fails to increase people's discretionary time, and expensive vehicles do little to increase happiness – the benefits are captured by competition and offset by increased costs. Transport market reforms prevent this by testing consumer demand, improving mobility options, and reducing total costs.

Sustainable development goals provide another reason to implement market reforms that increase transportation system efficiency. Sustainable development emphasizes the importance of balancing economic, social and environmental objectives. It emphasizes a *conservation ethic*, which accepts ecological and social constraints on resource production and strives to maximize the social welfare provided by a given level of resource consumption (Wackernagel and Rees, 1996; *Redefining Progress*). In particular, sustainable transportation requires maximizing transport economic efficiency, minimizing consumer costs, maximizing energy efficiency, minimizing the amount of land paved for roads and parking facilities, improving accessibility options for physically and economically disadvantaged people, and minimizing pollution impacts. The transportation market reforms described in this report help achieve these objectives. More comprehensive analysis, which considers a wider range of planning objectives, tends to increase the justification for market reforms that increase efficiency and reduce external costs.

Criticisms and Responses

Transportation market reforms are criticized on various grounds (Green, 1995; Dunn, 1998; “Evaluating TDM Criticism,” VTPI, 2007). Table 18 evaluates common criticisms.

Table 18 Efficient Market Criticisms and Responses

Criticism	Response
Market distortions favoring automobile use are offset by equal biases favoring other modes, such as transit subsidies.	Critics often understate automobile costs (such as parking costs), exaggerate alternative mode subsidies, and ignore other reasons to subsidize alternatives, such as equity objectives.
Motor vehicle external costs are offset by equally large external benefits, which justifies underpricing and policies favoring automobile transport.	This is generally untrue. Although mobility provides significant benefits, most are internal, enjoyed directly by users, or are economic transfers rather than net benefits. There is no evidence of significant <i>marginal external benefits</i> (you benefit if your neighbor increases their mobility).
Reforms, such as increased road and parking fees, they would harm lower-income people.	Underpricing driving is an inefficient way to help poor people since they tend to drive less than average, use alternatives more, and bear many external costs. More targeted and neutral subsidies suitable for any mode are more efficient and fair.
Since the motor vehicle and fuel industries are major economic sectors, many people assume that reduced vehicle and fuel consumption would economically harmful.	Motor vehicle expenditures provide less employment and business activity than most other consumer expenditures, particularly expenditures on public transit services. Market-based transportation reforms tend to increase overall economic efficiency, productivity and development.
Consumers benefit from driving and suburban land use.	Market reforms improve consumer options and test consumer demand. Only travel that consumers value less than its costs will be reduced.
Road and parking facilities are durable and can be difficult to expand, so planners may favor oversupply to accommodate possible future growth in demand.	These concerns can often be addressed with various demand management and design strategies (such as congestion pricing and structured parking), reducing the need for excessive supply.
More efficient pricing may increase transaction costs to governments and users.	Good planning, with integrated pricing systems using new pricing methods can minimize transaction costs.
Policy reforms may impose transition costs (inefficiencies due to change).	Good planning, with pricing introduced predictably and gradually, can minimize transition costs.
Any road and parking pricing revenues and cost savings would be squandered by governments or captured by landlords, providing no consumer benefits.	This could be true if governments and markets were very inefficient, but to the degree that taxes provide services and property markets are competitive, revenues and savings should ultimately benefit consumers. If governments require revenue, vehicle fees and taxes provide greater benefits than most other taxes because they also help increase transport efficiency.
Some reforms could increase fraud risk, such as odometer tampering.	Risk of fraud is actually modest if programs are designed with adequate security enforcement.

This table summarizes common criticisms of transportation market reforms. Many are exaggerated and most can be addressed with good planning and program design.

Distortions favoring automobile travel may have been justified when the automobile industry and roadway system were developing, to achieve economies of scale in vehicle and roadway production, but now that the highway system is mature and congested, and automobile use imposes significant external costs, such policies are no longer efficient. These distortions are now well established, so relatively aggressive action is justified to implement change, in order to gain the benefits of these reforms as quickly as possible.

A group of economists who advocate raising fuel taxes formed the “Pigou Club” (www.pigouclub.com). In response, critics formed a “No Pigou Club” (<http://nopigouclub.blogspot.com>) which raises the following criticisms, all of which are addressed in the market reforms recommended in this report.

- Fuel taxes are an inappropriate way to internalize many costs such as congestion and accident risk, which is why this report recommends various fees that reflect specific costs.
- Proposed fuel tax increases are arbitrary, ranging from \$0.50 to \$4.00 per gallon. The pricing reforms recommended in this report are based on specifically-defined principles: prices should reflect marginal costs and provide cost recovery by each group, unless a subsidy is specifically justified.
- Tax increases are politically difficult and revenues may be used inefficiently. Many of the recommended reforms are price shifts (such as pay-as-you-drive insurance and registration fees, and parking cashout), or can be considered fees for specific services (such as road and parking pricing), which should be easier to implement than new taxes. Much of the political and economic costs can be minimized through gradual and predictable implementation.

Virtually all strategies proposed here increase horizontal equity, since prices better reflect costs, reducing cross subsidies. Many also increase vertical equity by offering financial savings, reduced external costs, and increased travel options that particularly benefit lower-income households. However, there are legitimate equity concerns, particularly impacts of increased vehicle charges on lower income drivers in automobile dependent communities. Some specific strategies can be used to minimize these impacts.

- *Give special consideration to basic mobility options.* Target transportation service improvements, discounts and subsidies to transportation which provides *basic mobility*.
- *Use revenues to benefit lower income households.* If revenues subsidize transit services, replace property taxes, or provide additional services targeting disadvantaged people, the results should be progressive. Prices changes can be structured to benefit households and provide discounted “lifeline” levels of automobile use.
- *Provide some free mileage or an increasing tariff in distance-based charges.* For example, the first 4,000 miles of annual vehicle travel could be charged at a reduced rate. This would provide “basic mobility” similar to “lifeline” service provided by some utilities. (Although this could slightly encourage increased vehicle ownership).
- *Increase travel and housing options.* The impacts of increased motor vehicle prices are vertically inequitable to the degree that disadvantaged people are automobile dependent. Increased travel and housing choices can reduce this problem.

Conclusions

This study investigates the level and mix of mobility that can be considered economically optimal. This is not a question of whether motor vehicle travel is *good* or *bad*. Rather, it investigates the amount and type of mobility people would choose if transportation and land use markets were more efficient and equitable. Current market distortions result in economically excessive mobility. As a result, current levels of automobile use do not reflect true consumer preferences. In a more neutral and efficient market consumers would be expected to drive significantly less, use alternative modes more, choose more accessible locations, and be better off overall as a result.

Transport market distortions include underpricing of vehicle travel, biased planning practices, and land use policies favoring automobile-oriented development. These distortions are so well established they often seem “normal.” Although individual distortions may seem modest and justified, their impacts are cumulative and synergistic, significantly increasing mobility and automobile dependency. The resulting increase in motor vehicle traffic exacerbates many problems, including traffic congestion, facility costs, consumer costs, traffic accidents, environmental impacts, inadequate mobility for non-drivers, sedentary lifestyles, and costs resulting from sprawled land use. Many transportation problems are virtually unsolvable without correcting these distortions.

These distortions are both inefficient and unfair. They force consumers to pay more than they would choose with more efficient pricing and better options. They result in cross-subsidies from less to more mobility households, are regressive with respect to income, and reduce accessibility options for non-drivers. Described differently, market distortions that make mobility cheap make other goods more costly, including housing (due to additional parking costs and taxes), health (due to increased crash injuries, pollution exposure, and reduced physical fitness), and accessibility (due to congestion and land use dispersion). These inefficiencies and costs absorb a major portion of economic growth and reduce the social welfare provided by increased wealth.

No single reform can correct all existing distortions. More optimal markets require several changes from current practices:

- Reduce bias in transport planning and investment.
- Apply least-cost planning principles to transportation investments.
- Improve the quantity and quality of alternative modes, at least to the degree that could be self-financing, and more if justified to achieve objectives such as equity and sprawl reduction.
- Convert fixed charges into variable charges.
- Internalize many costs that are currently external.
- Apply business principles to road transport (such as requiring users to pay the equivalent of rents on land devoted to roadway rights-of-way).
- Remove market distortions that favor automobile dependent land use patterns.

Optimal transport markets result in each mode being used for what it does best. For example, walking and cycling are efficient for local errands, ridesharing and public transit for personal travel on major corridors, and automobile travel for travel to dispersed destinations, or for travel that has special requirements, such as carrying loads. Full implementation of market reforms would probably reduce motor vehicle use 35-50%. Put another way, a third to half of current motor vehicle use results from market distortions. Correcting these distortions would provide significant savings and benefits to consumers and the economy. Since transport activity is a large and growing portion of the economy, these benefits are large and likely to increase in the future.

Transportation and land use planning decisions can create self-fulfilling prophecies since there are often trade-offs between different modes. Automobile transport tends to crowd out other modes and create a self-reinforcing cycle of increased automobile dependency. Some decisions leverage large, durable effects. Described more positively, reforms that improve transport options and create more efficient prices can provide large benefits, many of which are indirect and difficult to quantify, and so tend to be undervalued in conventional planning, such as increased community cohesion and livability, improved mobility for non-drivers, and improved public health and fitness.

Until transportation markets are significantly reformed, other, less efficient interventions may be economically justified on second-best grounds. For example, until automobile travel is efficiently priced there are justifications for requiring major employers and other trip generators to implement mobility management programs, to subsidize and favor public transit, and even to prohibit motor vehicle use in certain areas or certain times.

These reforms face numerous obstacles. These can be minimized by good planning and management practices that include making price changes predictable and gradual, providing adequate opportunities for public involvement, by performing case studies and demonstration projects, and by taking measures to address specific public concerns. Easier reforms, such as pay-as-you-drive insurance and registration fees, parking cash out, and congestion pricing of existing road tolls should be implemented first, with gradual increases in parking fees, weight-distance fees and emission fees over time.

Transportation market reforms are increasingly important as society becomes wealthier because the potential demand for motorized travel is virtually unlimited. If such mobility imposes even small external costs per mile, total external costs can be large. Wealthy communities can bear these additional costs, but it is inefficient and particularly burdensome to people who cannot drive or afford a personal vehicle, who must either accept a much lower level of accessibility than their peers, or devote an excessive portion of their income to transport. If people identify themselves simply as motorists or consumers they will be tempted to support policies that favor automobile travel (such as low fuel prices, unpriced roads and parking), but if they recognize other roles – taxpayers, parents, community members – they may support reforms.

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