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Socially Optimal Transport Prices and Markets

Principles, Strategies and Impacts

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Abstract

This paper investigates the amount and type of mobility (physical travel) that is optimal for society overall. It asks, "How much and what type of travel would people choose if the transportation system reflected efficient market principles including consumer sovereignty, cost-based pricing and neutral public policies." It discusses these principles, identifies existing transport market distortions and reforms, estimates how such reforms would affect mobility, and investigates resulting economic impacts. This analysis indicates that in a more optimal market consumers would choose to drive less, use alternative modes more, choose more accessible locations, and be better off overall as a result. Although previous studies have evaluated individual transport market reforms, few have considered their cumulative impacts.

Summarized in
Economically Optimal Transport Prices and Markets: What Would Happen If Rational Policies Prevailed?
paper 11, presented at the International Transportation Economic Development Conference
(https://tti.tamu.edu/conferences/ited2014); at www.vtpi.org/ITED_optimal.pdf.

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Preface: What Is Best?

A cold and drafty house is uncomfortable, but so is one that is hot and stuffy. Bland food is unpleasant, but so is excessively spicy food. The Duchess of Windsor once said that a woman can never be too thin or a man too rich, but few people really want anorexic, greedy or single-minded mates. With few exceptions, the best option is one that balances various objectives, called *optimality* in this report.

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

There are certainly many situations in which automobile travel is the most efficient transport option, and many situations in which other transport options are most efficient overall, considering all impacts. And there are situations in which automobile travel seems most efficient to users, but really is not, when external impacts are consided. Although few motorists want to give up motor vehicle travel altogether, many might prefer to drive somewhat less and use alternatives more, provided those are convenient, comfortable, safe and affordable. It is likely that, given better options and more efficient incentives, total mobility would decline in ways that increase efficient and total benefits.

This has important implications for transportation policy and planning practices. To the degree that vehicle travel is economically excessive, accommodating more vehicle travel is harmful, making individual consumers and society worse off overall. Described more positively, market reforms discussed in this report can help reconcile existing conflicts between individual and social objectives, creating a truly optimal transportation system.

I will begin with the proposition that in no other major area are pricing practices so irrational, so out of date, and so conductive to waste as in urban transportation.
- William Vickrey, "Pricing in Urban Transportation," *American Economic Review*, 1963.

Introduction

Transportation has tremendous economic, social and environmental impacts. It affects our economic productivity, what we consume, our social relations, and the quality of our environment. It is therefore important to optimize our transportation system to maximize net benefits and help achieve other social objectives such as social equity and public health.

Mobility provides many benefits, but it also incurs significant costs. Maximizing transport system benefits therefore requires achieving the optimal amount and mix of mobility. For example, to transport heavy loads a truck is generally more efficient than a horse. For long-distance trips, air travel is generally more efficient than driving, and for medium-distance trips, driving is generally more efficient than walking. On the other hand, since driving incurs significant economic costs for vehicles, fuel, roads, parking, accident risk and pollution damages, walking and bicycling are often more efficient than driving for short trips by healthy people that involve light loads.

As a result, either too little or too much vehicle travel is economically inefficient. For example, a transport system may be economically inefficient if trucks cannot be used to transport heavy loads due to arbitrary regulations or inadequate infrastructure, since this reduces their productivity; but it can also be economically inefficient if residents cannot easily walk and bicycle when running local errands due to inadequate sidewalk and path infrastructure, since this forces them to drive for trips that could be made more cost effectively by non-motorized modes. Similar, it is inefficient if a lack of public transit service, underpricing of road and parking facility use, or land use policies that favor sprawl, increase per capita vehicle travel.

Policies that reduce transportation costs increase efficiency, but policies that externalize costs and shift cost burdens to other economic sectors reduce efficiency. For example, shifting from walking and horse travel to train and automobile reduced the costs of transport, resulting in increased mobility, which provided true benefits to society. However, the additional vehicle travel that results if transport costs are externalized, for example, if road and parking facility costs are borne indirectly through general taxes and development fees, rather than direct user fees, the additional vehicle travel that results is economically inefficient and harmful to society overall.

Current transportation systems are distorted in various ways that often result in economically inefficient transport activity. For example, in some situations, consumers lack viable transport options: they would prefer to drive less and rely more on walking, bicycling, public transit or delivery services, if the quality of these alternatives were better. In addition, many costs of travel are either fixed or external; this underpricing results in economically excessive mobility, travel that consumers would choose to forego is they were confronted with the actual costs of their transport decisions.

If the transport system were more efficient, offering consumers better transport and location options, and efficient pricing of roads, parking, insurance and fuel, consumers would likely choose to drive less, rely more on other transport modes, choose more accessible locations that require less driving, and be better off overall as a result.

During the last century, motor vehicle travel increased significantly, use of alternative modes (walking, cycling and public transit) declined, and use patterns became more automobile-oriented. Are the results optimal? Do these shifts reflect societal needs?

- *Superior performance.* Even if consumers have alternatives they continue to rely on automobile travel because it is truly optimal.
- *Prestige.* Consumers have viable alternatives but are embarrassed to use them, and so continue to rely on automobile travel.
- *Inadequate alternatives.* Planning distortions reduce transport and location options forcing consumers to drive more than optional.
- *Mis-pricing.* Underpricing of roads, parking, insurance and fuel encourages consumers to drive more than what is overall optimal.

All four factors probably contribute to high per capita automobile travel and automobile-oriented land use patterns. To the degree that prestige, inadequate alternatives or mis-pricing stimulate vehicle travel and sprawl, the resulting transport and land use patterns are suboptimal, and society could benefit overall from policy and planning reforms.

This report explores these issues. It investigates the type and amount of mobility (physical travel) that is overall optimal to users and society. It asks, "What amount and mix of travel would people choose if transport and land use policies reflected optimal pricing and planning principles." This analysis defines efficient market principles, identifies transport market distortions and potential reforms, estimates the changes in mobility these reforms would cause, and discusses implications of this analysis to transport policy and planning.

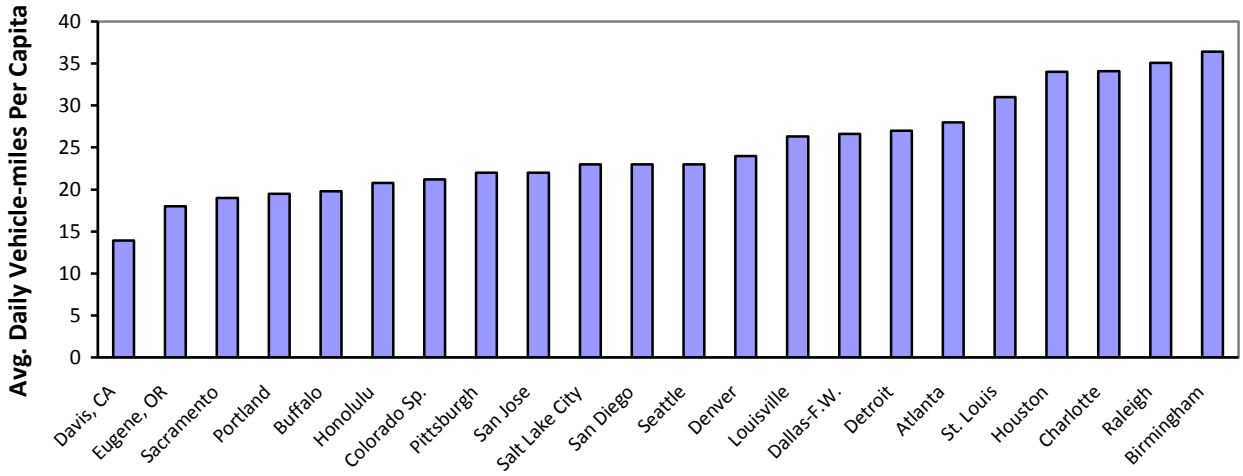
Although previous studies have investigated individual transportation market distortions and reforms, few evaluate them comprehensively, considering their cumulative impacts. Those include Dings, et al 2002; Lee 1992; Matthews and Nellthorp 2012; Parry, Walls and Harrington 2007; Proost, et al. 2002; Proost and Van Dender 2008; and Safirova, Houde and Harrington 2007.

This report builds on previous research by the Victoria Transport Policy Institute, including the report *Transportation Cost and Benefit Analysis* (Litman 2008), which evaluates the costs of various types of transportation; the *Online TDM Encyclopedia* (VTPI 2008), which describes various mobility management strategies and evaluates their benefits and costs; and *Comprehensive Transportation Planning* (Litman 2009), which investigates the degree to which current transport planning considers impacts and options, and describes methods for more comprehensive analysis.

Measuring Mobility

Mobility refers to the amount and type of travel that occurs in an area, typically measured as *per capita vehicle travel* (miles or kilometers) and *mode share* (the portion of total travel by each mode). Figure 1 illustrates per capita vehicle travel for various U.S. cities.

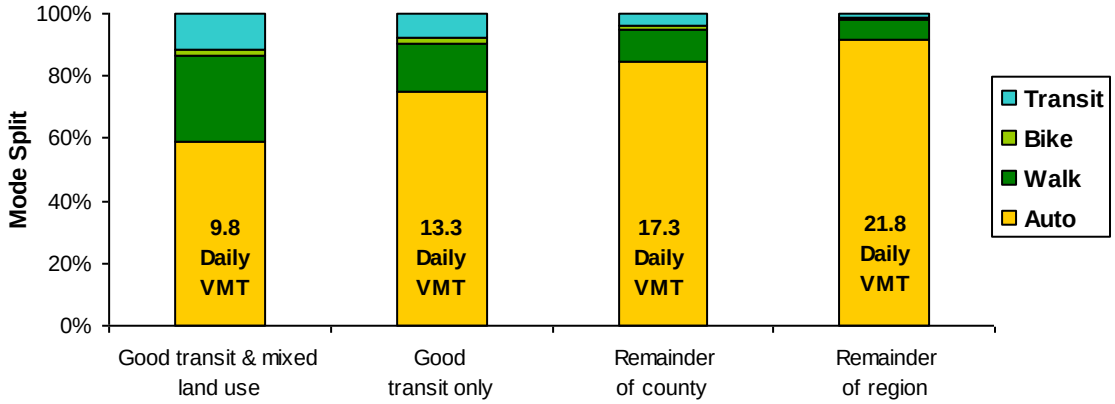
Figure 1 **Vehicle Mileage Per Capita in Selected US Urban Areas** (FHWA 2007)



Per capita vehicle travel varies significantly between U.S. cities, from less than 15 to more than 35 average daily vehicle-miles. This results, in part, from differences in transport and land use policies.

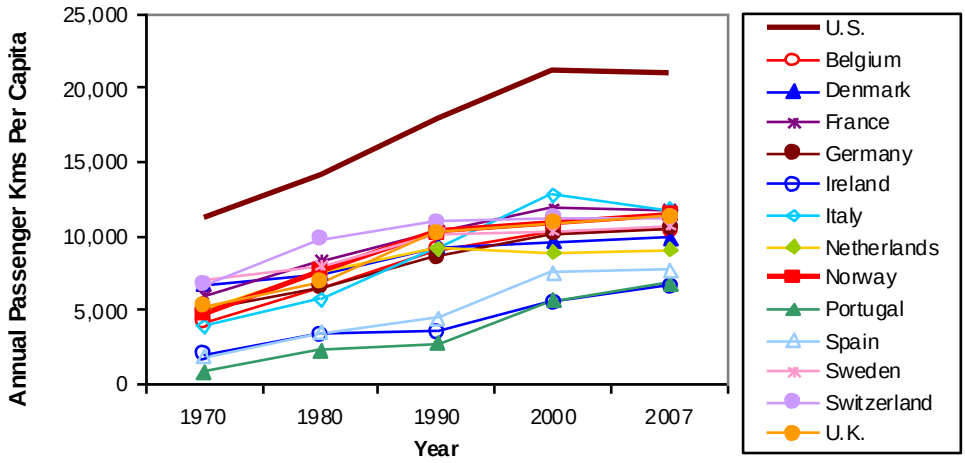
Similar variation exists within urban regions, as illustrated in Figure 2. Residents of more accessible and multi-modal neighborhoods tend to drive half as much, and rely more on alternative modes, than in more automobile-dependent locations. Although this partly reflects self-selection (people who prefer using alternative modes choose more multi-modal locations), this generally explains less than 40% of variation (Cervero 2007).

Figure 2 **Portland Mode Share and Mileage** (Ohland and Poticha 2006)



People who live in transit-oriented developments drive less and rely more on alternative modes. "Daily VMT" indicates average daily vehicle miles traveled per capita.

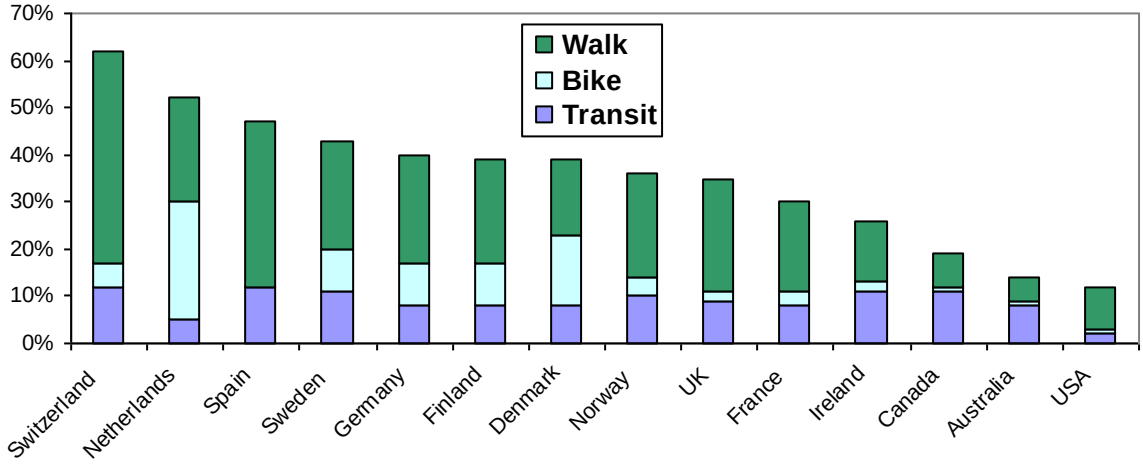
Figure 3 **Per Capita Passenger Travel Per Capita** (EC 2008; FHWA 2008)



Per capita vehicle travel peaked about the year 2000 in most affluent countries. The level at which mobility peaks is affected by transportation and land use polices.

Even greater variation exists between countries. Figure 3 shows mobility trends in selected OECD countries. Figure 4 shows mode share for several affluent countries. These illustrate three points. First, mobility varies significantly, even between areas with similar incomes and geography. Second, although motor vehicle travel grew steadily during the last century, it appears to have peaked in most affluent countries. Third, the level at which mobility peaks varies, in part due to public policies. For example, Southern California is similar in size and population to The Netherlands, but Californians drive about twice as much as the Dutch due to differences in fuel taxes, transport planning, and development policies.

Figure 4 **International Mode Shares** (Bassett, et al. 2008)



Transportation mode share vary significantly among affluent countries.

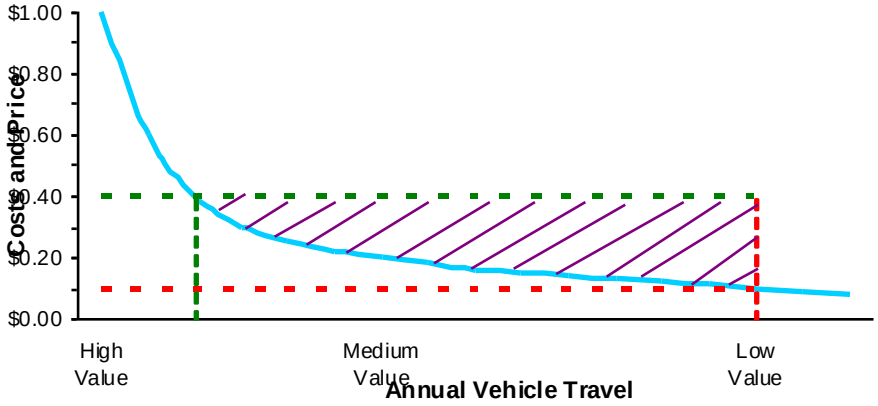
Accessibility Versus Mobility

To evaluate transportation it is important to appreciate the distinction between *accessibility* (people's ability to reach desired goods, services and activities) and *mobility* (physical movement). Accessibility is the ultimate goal of most transport activity excepting a small portion for which movement is an end in itself, such as jogging or cruising; even recreational travel usually has a destination such as a picnic site or resort.

All else being equal, increased mobility improves accessibility. For example, increasing travel speeds 30% approximately doubles the number of destinations accessible in a given time period. But other factors also affect accessibility including land use patterns (dispersion of homes, worksites and services), and the quality of mobility substitutes such as telecommunication and delivery services. Planning decisions often involve tradeoffs between different types of access. For example, money and land devoted to automobile facilities is unavailable for other modes, and land use patterns that maximize automobile access tends to be less accessible by other modes (automobile access favors dispersed development along highways which tends to be difficult to reach by walking, cycling and public transit). Current planning tends to evaluate transport system performance primarily on mobility, using indicators such as average traffic speeds and roadway level-of-service, and so tends to undervalue accessibility improvements such as increased proximity.

Demand for mobility is potentially unlimited (Figure 5). If costs decline, consumers can usually find reasons to increase their vehicle travel. For example, if supersonic travel was sufficiently subsidized many people would probably fly around the world for a dinner party, even if comparable services were available nearby, for novelty and prestige sake. As a result, market distortions that underprice automobile travel can result in vehicle travel with negative value (total costs are larger than user benefits).

Figure 5 **Mobility Demand Curve**



The automobile travel demand curve (light blue line) has a "long tail" – as prices decline people find reasons to increase their annual mileage even if marginal benefits are small. If automobile travel has a full cost of 40¢ (green dashed line), but much of this is external or fixed so motorists only perceive 10¢ per mile (orange dashed line), consumers will drive more than is economically efficient. Purple hatched area indicates the area of inefficiency.

Market Principles, Distortions and Reforms

Markets are systems through which resources (goods, services, land, labor, etc.) are exchanged. An efficient market is like a well-tuned machine: Consumers choose the goods and services that best meets their needs and preferences, with prices maintaining equilibrium between *demand* (the amount consumers will purchase under specific circumstances) and *supply* (the type and quantity of goods producers will provide at a particular price). This efficiently and equitably allocates resources, maximizing benefits.

But love of markets must not be blind. Optimal markets must reflect certain principles, including adequate consumer options, neutral public policies and efficient pricing. This report evaluates the optimality of transportation markets, which includes all transport system components: vehicles, fuel, facilities and services. Since location decisions affect transportation, land use policies (such as the location of development and the supply of parking) are also transport market components.

Economic optimality refers to market conditions that maximize *social welfare* (total human happiness). An *optimal market* refers to the physical and social structures that allow this to occur. According to economic theory, optimal markets must reflect certain principles including *consumer sovereignty*, *neutral public policies,* and *efficient pricing* (Gómez-Ibáñez, Tye and Winston 1999; Vermeulen, et al. 2004; Ricci, et al. 2006; Litman 2006a). Violations of these principles are called *market distortions*, and distortion corrections are called *market reforms*. This section describes these principles, investigates the degree to which current transport markets reflect them, explores distortions and appropriate reforms, and investigates how their implementation would affect mobility.

1. Consumer Sovereignty

Consumer sovereignty (also called *consumer choice*) means that markets respond to consumer demands by providing the combination of goods and services they want to purchase. For transportation this can include:

- Modes, such as walking, cycling, public transportation, telework and delivery services.
- Vehicles, including various vehicle types (cars, trucks, hybrids, alternative fuels), price structures (expensive, cheap, new, used) and ownership options (leased, shared, etc.).
- Service quality, allowing consumers to choose from various levels of quality and price, such as being able to pay for uncongested roadways, more convenient parking, and more comfortable public transit services.
- Price structures, including various public transit fares, and distance-based vehicle insurance and registration fees, and rental vehicles.
- Land use and locations, such as between automobile dependent and more multi-modal neighborhoods and destinations.

If consumers lack adequate transport and land use options, the resulting mobility patterns are not necessarily optimal. High levels of automobile travel can only be considered optimal if consumers have viable alternatives. This is not to say that every possible option must be available everywhere, but in general, consumers benefit from improved options. In an efficient market, all cost-effective options should be available, including those that are self-financing (user fees cover

costs) or are more cost effective than existing options (for example, if ridesharing or public transit improvements would require less subsidy than expanding roads and parking facilities).

Current markets tend to respond to consumer demands for motor vehicles and related services (fuel, repairs, accessories, parking, etc.), but alterntives are often limited and inferior. In most North American communities, walking and cycling is difficult and dangerous, public transit is inconvenient, non-automobile modes are poorly integrated, and information about alternatives difficult to obtain, as anybody who travels around a typical American city without using a private vehicle generally finds apparent.

There are two possible explainations for this inadequacy of options: a lack of demand (nobody wants alternatives), or latent demand (people want alternatives that are not available) due to unresponsive planning. It is possible to find examples of both: sidewalks, paths and public transit services that receive little use, resulting in high unit costs, and situations where improved walking and cycling facilities inceased use of these modes, and public transit systems with crowded vehicles and growing ridership.

Determining whether available options are sufficient can be difficult because:

- Transport systems are integrated. Low demand for an option (such as a bike lane with few users) may reflect a lack of bike parking at destinations rather than an absence of demand.
- Service quality is important. For example, that public transit ridership declines as incomes increase may indicate that consumers want higher quality (such as premium bus and train service) rather than an absolute lack of demand for these modes.
- Many transportation options experience scale economies and require a critical mass to be effective, so small-scale programs may fail to reflect true potential demand.
- Demands shift over time. Options with little demand in the past may become justified due to demographic and economic trends. For example, aging population, rising fuel prices, and increased health concerns may increase future demand for alternative modes.

Although it may be difficult to determine whether the transportation options available in a particular situation are truly optimal, in general, increased transport system diversity tends to improve market efficiency and equity, and policies that arbitrarily reduce transport options can be considered market distortions. The next section of this report examines whether planning distortions contribute to inadequate transport options.

2. Neutral Public Policies

Transportation is "co-produced" by consumer (who purchase shoes, bicycles, vehicles and fuel, make travel decisions, and choose locations), businesses (which produce vehicles and fuel, provide parking, operate transportation services, and develop land) and governments (which supply and regulate sidewalks, paths, roads, parking facilities, and land use development). Many types of policy and planning decisions affect transportation as indicated below. Neutral public policies are therefore a necessary foundation for an efficient market.

Table 1 **Policy and Planning Decisions That Affect Transportation**

Facilities	Services	Land Use	Pricing
• Transport funding • Road and parking facility design • Road space allocation • Traffic regulations	• Public transit service quality • Taxi regulations	• Zoning codes • Parking requirements • Location of public facilities	• Transportation taxes • Transport fares • Vehicle insurance

Many policies and planning decisions affect transportation options and activities.

Optimal planning must reflect the following principles:

- *Comprehensive analysis* that considers all significant options (including alternative modes and demand management strategies), impacts (benefits and costs) and objectives (including *efficiency* objectives, *equity* objectives, and *resilience* objectives).
- 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 equally with mobility improvements.
- *Unbiased decision-making*, which does not arbitrarily favor certain modes, groups or activities.

Even modest planning distortions can have large impacts due to leverage effects. For example, a few million dollars of federal grants can leverage tens of millions of dollars of state and local government transportation expenditures, which can leverage hundreds of millions of consumer transportation expenditures, affecting billions of dollars worth of land use development, and tens of billions of dollars worth of total economic, social and environmental impacts. Similarly, generous parking requirements and limits on development density and mix can discourage urban redevelopment and encourage dispersed, urban fringe development that results in automobile-dependent communities.

The following section examines the degree to which current transport and land use planning practices reflect these principles.

Transport Planning

Current transport planning tends to be biased in various ways that favor mobility over accessibility and automobile travel over other modes (Bartholomew 2007; Brown, Morris and Taylor 2009; Goodwin 2004; EVIDENCE 2014; Hallenbeck, et al. 2006; Litman 2009; Pantell 2009; Schneider, Handy and Shafizadeh 2014). For example:

- Most transport planning is mobility-oriented. This perspective assumes that the goal is to maximize travel speeds, even if this creates barriers to non-motorized modes (for example, due to wider roads and higher vehicle traffic volumes and speeds) and disperses destinations (for example, due to generous minimum parking requirements which discourage infill development and increase land requirements), and tends to overlook qualitative improvements that increase traveler comfort and user information.
- Indicators used to evaluate transport system performance (average traffic speed, roadway level-of-service, and parking spaces per 1,000 square foot of building space) primarily reflect automobile travel conditions. This emphasizes automobile problems and ignores impacts on other modes (DeRobertis, et al. 2014).
- Transport statistics undercount nonmotorized travel by ignoring short trips, off-peak trips, children's 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 major portion of tranpsort funding is dedicated to roads and parking facilities and cannot be used for alternative modes or mobility management programs even if they are more cost effective overall (CEE 2007). Table 2 summarizes how current planning and funding practices favor highways over transit investments. Much less funding is available for other modes, particularly non-motorized modes. For example, although walking and cycling represent 5-15% of all trips (when correctly measured), and increased walking and cycling can provide many economic, social and environmental benefits, non-motorized facilities receive only an estimated 1-3% of total surface transportation expenditures. Similarly, federal transportation funding provides smaller matching funds and imposes greater evaluation requirements on transit projects than for highway projects.

Table 2 **Highway Vs. Transit Planning** (Beimborn and Puentes 2003; Sussman 2001)

	Highways	Transit
Project Criteria and Justification	No cost effectiveness requirement.	Requires detailed cost effectiveness analysis and financial plan.
Federal Funding	Federal match is 80-90%. Most states dedicate fuel tax to highways, favoring highway improvements.	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. A detailed process is mandatory for comparing alternatives.
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.

- Most jurisdictions impose generous minimum parking requirements. This subsidizes vehicle ownership and use, and disperses land use development, which favors automobile travel over other modes.
- Traffic models and 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 expanded supply. Generated traffic impacts are generally ignored, which exaggerates roadway expansion benefits.
- Mobility management (such as congestion pricing, parking pricing and commute trip reduction programs) is generally considered a last resort approach implemented only where capacity expansion is infeasible, and so these strategies are seldom implemented. Mobility management tends to lack reliable funding, institutional support and professional training comparable to what is available for automobile programs.
- Some tax policies favor automobile travel. For example, vehicle parking and company cars are attractive employee benefits because they are taxed at relatively low rates.
- Most transport planning is performed by organizations that were originally *highway* agencies. Although most have been renamed *transportation* agencies, few have been restructured to fully support multi-modal planning and mobility management. Many planning resources (publications, software and training programs) focus on motor vehicle planning and overlook or undervalue alternative modes.
- Automobile and air travel are considered modern and prestigious, while alternative modes are often considered outdated and stigmatized.
- Politically influencial people (public officials, business owners, planners, etc.) tend to be busy, higher-income professionals who rely on automobile transportation and seldom depend on alternative modes. This skews policies and day-to-day planning decisions toward automobile transportation.
- Public transit costs are concentrated in government-funded projects, while automobile transport costs are widely dispersed, including private costs (for vehicles), government costs (for roads) and business costs (for parking). This makes transit projects seem costly compared with highway expansion.

Table 3 **Automobile Versus Transit System Costs**

	Public Transit	Automobile Transport
Routes	Public (roads and tracks)	Public (roads)
Vehicles	Public (buses and trains)	Private (cars and trucks)
Terminals	Public (stops and stations)	Mostly private (parking)

Public transit projects generally include routes, vehicles and terminals. Highway projects only include routes, and generally ignore vehicle and parking costs. This makes transit system expansion seem costly compared with highway expansion.

- Alternative modes experience economies of scale (quality and efficiency tend to increase with use), which are generally ignored in evaluation. This undervalues polices that increase their utilization and size.

How Urban Transport Projects are Appraised

A major review of transportation project economic evaluation practices found a number of biases which tend to favor "traditional" transport system improvements, such as roadway expansions, over sustainable transport projects that result in more efficient use of transport resources, such as active (walking and cucling) and public transport improvements, pricing reforms, smart growth development policies, and other mobility management strategies (EVIDENCE 2014). These biases include:

- The relatively new nature and small size of sustainable transport projects, such as pedestrian and cycling improvements, incremental public transit improvements, and commute trip reduction programs. As a result, they are often overlooked and seldom considered alternatives to major roadway projects. The report authors recommend addressing this by bundling individual strategies into Sustainable Urban Mobility Plans (SUMPs) which can be evaluated as an integrated project.
- The limited set of impacts (benefits and costs) considered in transport project evaluation, which are dominated by vehicle travel time savings. Sustainable transport projects tend to provide a much larger set of economic, social and environmental benefits, including improved mobility for non-drivers, vehicle ownership savings, parking cost savings, energy conservation, pollution emission reductions, improved public fitness and health, and local economic development.
- Optimistic bias concerning the ability of roadway expansions to reduce traffic congestion and associated costs such as accidents and pollution emissions. In practice, roadway expansion benefits are often offset overtime by induced vehicle travel and other rebound effects (more and faster vehicle travel).
- Data limitations, such as inadequate information on walking and cycling demand, the impacts that improved user information or travel comfort have on transit utilization, or the true effects that transport projects have on public safety and health, consumer costs or economic development.

Land Use Planning

Transportation and land use are two sides of the same coin: Transportation planning decisions affect land use development patterns, and land use planning decisions can affect transport options and activities (Litman 2005).

Critics sometimes assume that smart growth policies consist primarily of regulations, such as urban growth boundaries, which limit urban expansion and increase development densities beyond what consumers demand. If true, this would result in development densities that are unjusifiabily high. However, urban growth boundaries are just one of many policies and planning practices that affect the amount and type of urban expansion that occurs. To measure these impacts, Lewyn and Jackson (2014) evaluate the types of land use regulations and their impacts on development patterns. Based on analysis of 25 typical jurisdictions, they found that regulations which encourage sprawl, including minimum parking requirements and maximum density limits, are far more common while their converse: strict urban growth boundaries, parking maxima and density minima are uncommon and not very restrictive. For example, some jurisdictions allow no more than 5 parking spaces per 1,000 square feet of office space, and at least one house per acre, which allows sprawled development.

Until the 1950's, most communities were designed to be accessible and multi-modal, with compact, mixed development, well-connected sidewalks and streets, and commercial activity

concentrated in downtowns. During the second half of the Twentieth Century development became more automobile-oriented. Proponents claim that these changes simply reflect consumer preferences; that land use policies and development practices responded to rational consumer tradeoffs which accept the constraints of automobile dependency to achieve the benefits of suburban locations. However, critics argue that these development pattens also reflect various planning distortions that favored sprawl over more compact development, such as generous spending on highways and parking facilities, inflexible zoning codes, lending practices and redlining which favored suburban housing and discouraged redevelopment of urban communities (Blais 2010; Levine 2006).

Much of the preference for suburban locations reflects economic and social attributes such as newer housing stock, and lower crime rates, better schools, increased economic stability, and greater prestige, rather than unique physical features of suburbs, as indicated in Table 4.

Table 4 **Attributes Contributing To Consumer Preference for Suburbs**

Economic and Social Features	Unique Physical Features
Newer housing stock	Larger lots
Increased security (less crime)	More open space
Better public schools and services	Better automobile access
Increased economic stability	
Greater prestige	

Households choose suburban locations for a variety of attributes, many of which could be provided in more accessible, multi-modal locations.

Market studies indicate that many households prefer more accessible, multi-modal locations, provided they have features such as quality schools, security and prestige (Litman 2009b). For example, the National Association of Realtors's *2004 American Community Survey* found that consumers value walkable neighborhoods and shorter commutes (Belden, Russonello & Stewart 2004). Six in ten prospective homebuyers indicated a preference for a neighborhood that offered a shorter commute, sidewalks and amenities like shops, libraries, schools and public transport within walking distance rather than a sprawling community with larger lots, poor walking conditions and longer commutes.

Similarly, a California survey found that, although 86% of respondents prefer single-family homes, 47% prefer a walkable, mixed use neighborhood; 49% would choose a smaller house if it provided a shorter commute; and 31% would choose a high-density neighborhood if it had convenient public transit (PPIC 2002). A survey of Houston, Texas residents (Blueprint Houston 2003) asked, "Would you personally prefer to live in a suburban setting with larger lots and houses and a longer drive to work and most other places, or in a more central urban setting with smaller homes on smaller lots, and be able to take transit or walk to work and other places?" Fifty-five percent of respondents chose the "Central urban setting" and only 37% chose the "Suburban setting."

The Atlanta, Georgia SMARTRAQ study found that only about 5% of homes in the region are in compact and walkable neighborhoods, and only 40% of respondents indicated that they could walk to any nearby shops and services. Yet, 20% to 40% of respondents expressed a very strong preference for the most compact and walkable neighborhoods (depending on which attributes were considered), 49% prefer a neighborhood where residents can walk to nearby shopping, and

55% prefer a community with smaller lots if it offers shorter commutes. About a third of metro Atlantans living in automobile-dependent, suburban locations indicate they would prefer a more walkable environment but traded it off for attributes such as affordability, school quality, or perception of crime. This suggests a significant undersupply of accessible, walkable neighborhoods.

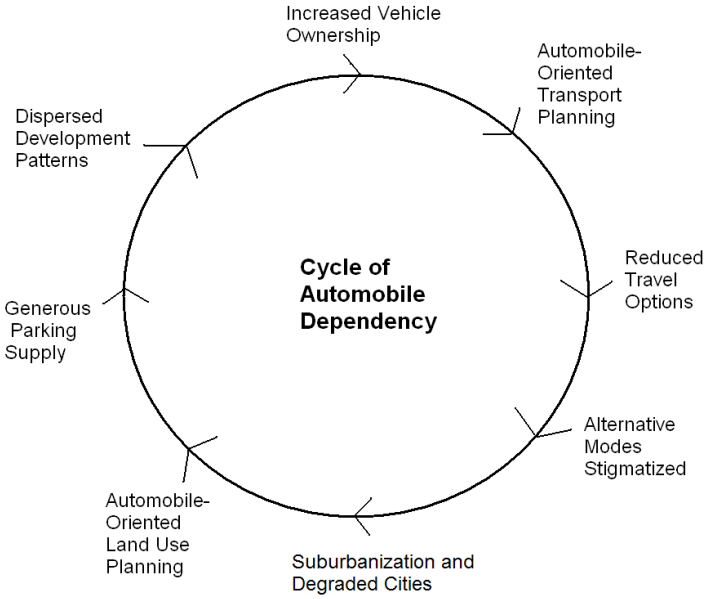
Market research indicates that demand for smart growth locations is likely to increase in the future due to demographic and economic trends such as aging population, rising fuel prices and changing preferences (Reconnecting America 2004; Thomas 2009). To the degree that planning practices unintentionally favor automobile-oriented, sprawled development and discourage the development of more accessible, multi-modal communities they reduce consumer value as well as stimulating economically excessive mobility. The following land use planning practices unintentionally increase automobile dependency and sprawl (Lewyn 2005 and 2006; Levine 2006; SGN 2002 and 2004):

- Generous public spending on roads and parking facilities, which often degrades urban neighborhoods and encourages sprawled development.
- Zoning codes and development polices that limit development density and mix, and require generous parking supply.
- Taxes and utility rates that fail to reflect the savings that result from more compact, accessible development.
- Public housing and infrastructure investment practices that tend to favor greenfield locations over redevelopment of existing areas.
- Lending policies that 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 2008).
- Middle-class flight to suburbs, leaving cities with concentrated social problems.

Cumulative Effects

Although individually these transportation and land use planning distortions may seem modest and reasonable, their impacts are cumulative and synergistic (total impacts are greater than the sum of individual impacts), particularly over the long-run, as automobile-oriented planning contributes to a self-reinforcing cycle of automobile dependency and sprawl, as illustrated in Figure 6.

Figure 6 **Cycle of Automobile Dependency and Sprawl**



Biased planning practices contribute to a cycle of automobile dependency and sprawl.

Some people claim that biases favoring automobile transportation are justified due to offsetting benefits or comparable biases favoring alternative modes (Dunn 1998; O'Toole 2006). These issues are evaluated in the box on the following page. Biases favoring automobile transport may have been justified during the early years of the Twentieth Century to achieve economies of scale in vehicle and roadway production, but once those systems matured such biases are no longer justified and are likely to be economically harmful.

This is not to suggest that automobile travel is harmful and should be eliminated. Automobile travel is the most efficient and appropriate mode for many trips. However, existing planning biases described above reduce transportation options and create more automobile-oriented land use patterns than is overall optimal. More neutral and efficient planning would likely result in a significantly more diverse transportation system than currently exists in most North American communities, providing various benefits.

Evaluating Possible Justifications For Favoring Automobile Transport
(Litman, 2004b; "Evaluating Criticism of TDM," VTPI 2008)

- *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. 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 them 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

Various planning reforms can help correct the distortions described above.

Transportation Planning Reforms

Improve transportation options and encourage use of efficient modes. To the degree that past planning distortions contributed to automobile dependency, special efforts are justified to improve transport system diversity. This can include special planning and funding to support alternative modes and create more integrated transport systems. More multi-modal planning can help integrate transport services, fares and ticketing, user information, infrastructure provision and management, transport and land use planning, and other public policies such as road, parking and fuel pricing (Preston 2012). Investments in alternative modes may be justified beyond what is indicated simply by mode share or cost effectiveness analysis to help correct decades of underinvestment. For example, if nonmotorized travel (walking and cycling) currently has 5% mode share, it may be appropriate to devote 15-25% of transport budgets to these modes to correct for past underinvestment and help achieve strategic objectives such as improved mobility for non-drivers, increased public fitness and health, and more compact land use development.

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 for equity sake (to provide basic mobility for non-drivers and cost savings to lower-income people), and to help achieve strategic objectives such as preserving greenspace and reducing future energy consumption). 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 for equity sake, to take advantage of economies of scale in the development of alternative modes, and to achieve strategic planning objectives such as urban redevelopment.

Apply more comprehensive analysis of transport planning options and impacts. *Least-cost planning* (VTPI 2008) refers to planning and investment practices that current existing biases favoring automobile transport by:

- Considering a wide range of transportation improvement options, including demand management strategies improvements to alternative modes and efficient pricing.
- Considering all economic impacts including indirect impacts such as user costs, parking, congestion, accidents, and pollution.
- Providing funding to the most cost-effective solution, including demand management strategies and alternative modes.

Improve transport modeling and economic analysis to account for all impacts, including the effects of generated and induced travel.

Land Use Planning Reforms

Various land use planning reforms can help create more accessible, multi-modal land use development (Levine 2006; Litman 2007; SGN 2004; Binger, et al. 2008):

- Establish integrated transport and land use development goals, objectives and targets.
- Improve planning coordination among various levels of government, such as between state and local transport agencies, and between local governments and school planners.
- Change zoning laws to allow higher densities, more land use mix, and more flexible parking requirements.
- Price utilities and fees to reflect the higher costs of providing public services to lower-density, dispersed locations, as well as the savings that result from more compact development.
- Correct tax policies that encourage sprawl, and reward more accessible, compact development.
- Provide targeted infrastructure improvements to roadways, schools, parks, utility lines in smart growth locations.
- Locate and design schools, parks and other public facilities for multi-modal accessibility.
- Support location efficient mortgages which recognize the potential transportation cost savings that households achieve by choosing more accessible, multi-modal housing locations and, as a result, increase 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.
- Limit urban expansion, particularly on ecologically valuable lands, with growth controls and greenspace preservation policies.
- Educate decision-makers about smart growth policies and benefits.
- Develop better tools for evaluating land use impacts.

Travel Impacts

These transportation and land use planning reforms tend to reduce automobile travel and increase use of alternative modes. As described earlier, surveys indicate that many people would prefer to drive less, rely more on alternative modes, and live in more accessible, multi-modal neighborhoods. To the degree this is true, these planning reforms benefit consumers in addition to external benefits such as reduced congestion and public costs. Cost-effective strategies (unit costs are equal or less than that of accommodating additional automobile travel) that benefit consumers overall can provide significant reductions in automobile travel and increase use of alternative modes. For example ("Success Stories," VTPI, 2008):

- *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, 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 10-40% less than national averages, and even greater reductions are possible if implemented with significant improvements in alternative modes (such as high quality regional transit) and transportation pricing reforms (CCAP 2008; Ewing and Cervero 2002; Litman 2005; Pratt 2007).

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 increased investment in alternative modes (such as busways and rail transit services), land use policies that improve accessibility (such as more compact and transit-oriented development), and pricing reforms (such as road and parking pricing). Since that modeling only applied to regional facilities, additional VMT reductions could be expected if such reforms were also applied to local planning.

3. Efficient Pricing

Price refers to users' *direct, perceived, variable costs*, the costs that affect 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 excessive consumption) or $2.00 (*overpricing*, which limits consumption and so reduces consumer benefits). Efficient pricing tests consumer *willingness-to-pay*, so society avoids devoting $2.00 worth of resources to produce goods users only value at $1.00. Roads and parking facilities not rationed by price will be rationed by congestion. Although consumers may dislike both pricing and congestion, pricing is more efficient because it allows higher-value trips to outbid lower-value trips, and provides revenue.

Optimal pricing requires trade-offs among various objectives, including efficiency, equity, transaction costs, and strategic objectives. Unpriced roads, parking or transit services may be appropriate to avoid transaction costs or achieve equity objectives. There are often differences between *theoretical* optimal pricing (that ignore transaction costs) and *functional* optimal pricing (which considers transaction costs). Newer pricing methods improve adjustability and reduce transaction costs, and so can allow functional pricing that better reflect theoretical optimum.

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 5 **Motor Vehicle Cost Categories**

Shorter Term Marginal Costs	Longer Term Marginal Costs	Sunk Costs
• Vehicle operation • Travel time • Facility wear • Congestion imposed on others • Accident risk • Pollution damages	• Vehicle and facility capital costs • Opportunity cost of facility land • Facility maintenance • Land value • Land use impacts (such as sprawl)	• 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

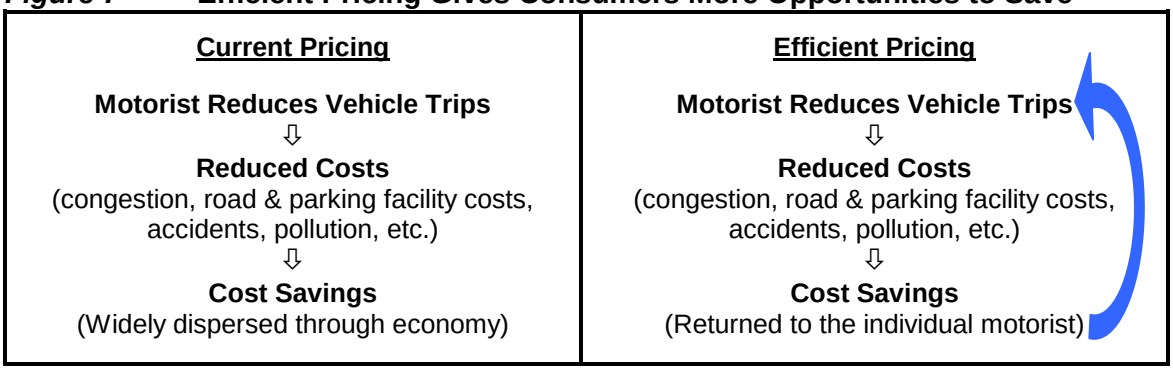
capital investments. Agricultural product prices include farmland rent and property tax costs, general taxes on most inputs, as well as normal return on capital. Failing to charge motorists the equivalent of rent and property taxes on roadway land, and general taxes on inputs such as fuel, underprices road transport relative to rail and transport relative to other land use 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.

Consumers often assume they benefit from 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), and underpricing increases external costs such as congestion. The choice therefore is really between paying *indirectly for congested facilities* or *directly for uncongested facilities*. Overall, consumers are better off paying directly because gives them more opportunity to save: If indirect financing people pay regardless of how much they drive, but with direct user fees consumers save when they reduce their consumption (Figure 7).

Figure 7 **Efficient Pricing Gives Consumers More Opportunities to Save**

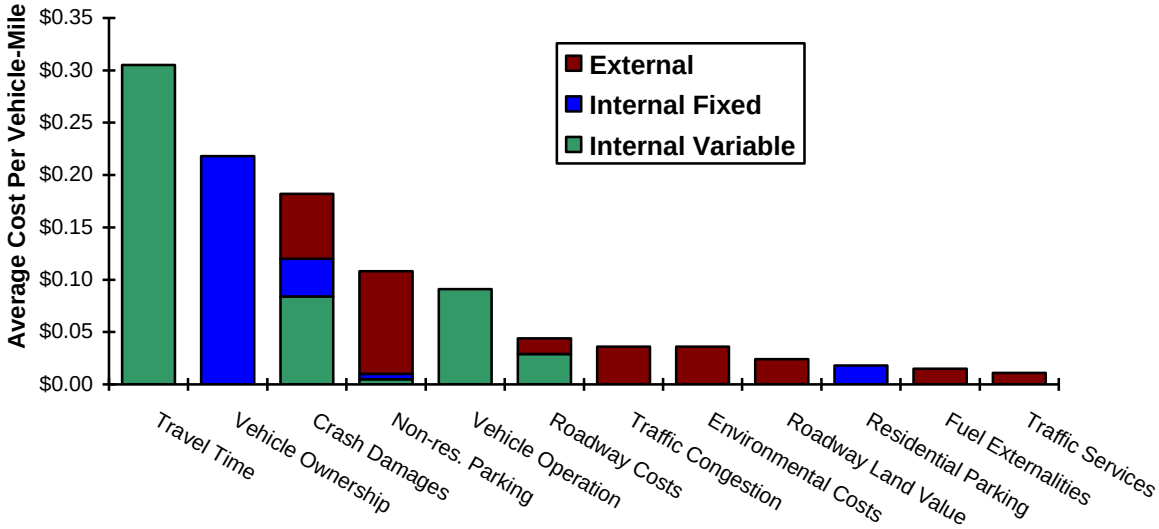


With current pricing, savings from reduced driving are dispersed through the economy. Efficient pricing returns more savings to individuals who reduce their driving.

Price Distortions

Several studies have investigated transport costs and optimal pricing (Murphy and Delucchi, 1998; Vermeulen, et al, 2004; Litman, 2008; *European Transport Pricing Initiatives*; Parry, Walls and Harrington, 2007; Delucchi and Murphy 2008). Figure 8 illustrates an estimate of these costs.

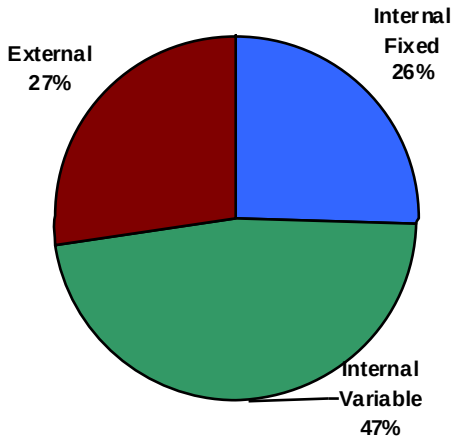
Figure 8 **Estimated Automobile Transport Costs** (Litman 2008)



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 9 illustrates the distribution of these costs.

Figure 9 **Automobile Cost Distribution** ("Transport Costs," VTPI, 2008)



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 (Dutzik and Inglis 2014). 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.

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.

Optimal Prices

This section discusses optimal pricing of various vehicle costs. For more information on costs see Vermeulen, et al (2004) and Litman (2008). For more information on pricing reforms see Burke (2014), ECMT (2000), Dings, et al (2002), van Essen, et al. (2004), VTPI (2008), PTUA (2009), and Zhang and Lu (2012).

Congestion Pricing

Congestion pricing (also called *value pricing*) consists of tolls structured to reduce traffic volumes to optimal levels on specific roadways, which typically means approximately Level-Of-Service *C* (TTI 2005; Van Amelsfort and Swedish 2015). Fees can vary based either on a fixed schedule or they can be *dynamic*, meaning that rates change in direct response to congestion levels. 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 replaces toll booths. Although only with experience is it possible to determine optimal prices, available modeling suggests that fees should 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 2008).

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 ("Barrier Effect," Litman, 2008). Efficient pricing of this cost requires road tolls that reflect the delays imposed at specific times and locations, taking into account non-motorized demand (the amount of walking and cycling that would occur if given the opportunity), and the degree to which a motor vehicle hinders this travel. It could be argued that the delay motorists impose on nonmotorized travel 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 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 the road user fees described next), or for general revenue (as a Pigouvian tax).

Table 6 **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¢
Total	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, 2008). 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 2008). Roads also impose various land use impact costs, such as stormwater management costs, heat-island effects and habitat loss ("Land Use Impacts," Litman, 2008). 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 7 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 7 **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¢
Totals	*0.3¢*	*3.5¢*	*11.5¢*	*20¢*

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, 2008). 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, 2008). 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 8 **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¢
Totals	*0.0¢*	*6¢*	*10¢*	*14¢*

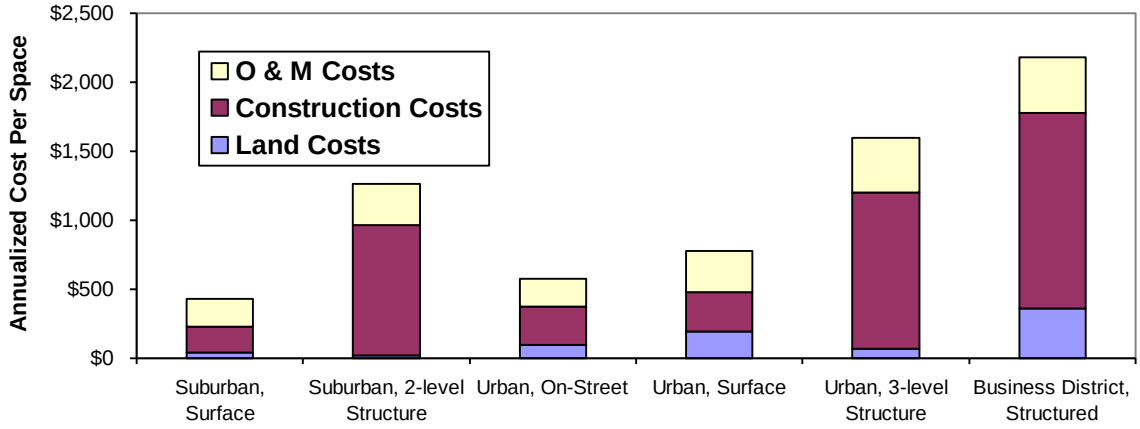
This table indicates optimal fees for the accident risk a vehicle imposes on other road users. Although insurance compensates a portion of these risks, vehicle insurance is a fixed rather than a variable charge, so the per-mile cost to motorists is virtually zero.

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 *cashed-out*, which means that consumers can choose the cash equivalent if they do not use it.

Figure 10 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, 2008). 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 10 **Typical Parking Facility Annualized Costs per Space** (Litman 2008)



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 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 for 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 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 9 **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¢
Totals	*0.7¢*	*6.5¢*	*12¢*	*20¢*

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 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, 2008). 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 10 **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¢
Totals	*0.0¢*	*1.0¢*	*4.0¢*	*8.0¢*

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 (Litman 2008; IMF 2010; Delucchi and Murphy 2008). 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 CO_2, 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 11 **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¢
Totals	*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 12 various transportation costs and their appropriate pricing.

Table 12 **Appropriate Pricing Of Various Transport Costs**

Cost	Pricing Method	How Calculated
Congestion	Time and location based vehicle fees or road tolls.	Prices are higher under congested conditions. Price to reduce traffic volume to optimum flow.
Roadway costs	Road tolls or weight-distance fees.	Cost allocation applied to all roadway costs, including traffic services, rent and taxes on roadway land.
Accident risk	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 13 summarizes middle-range values of these fees. These are averages; actual fees would vary depending on factors such as vehicle type, time and location.

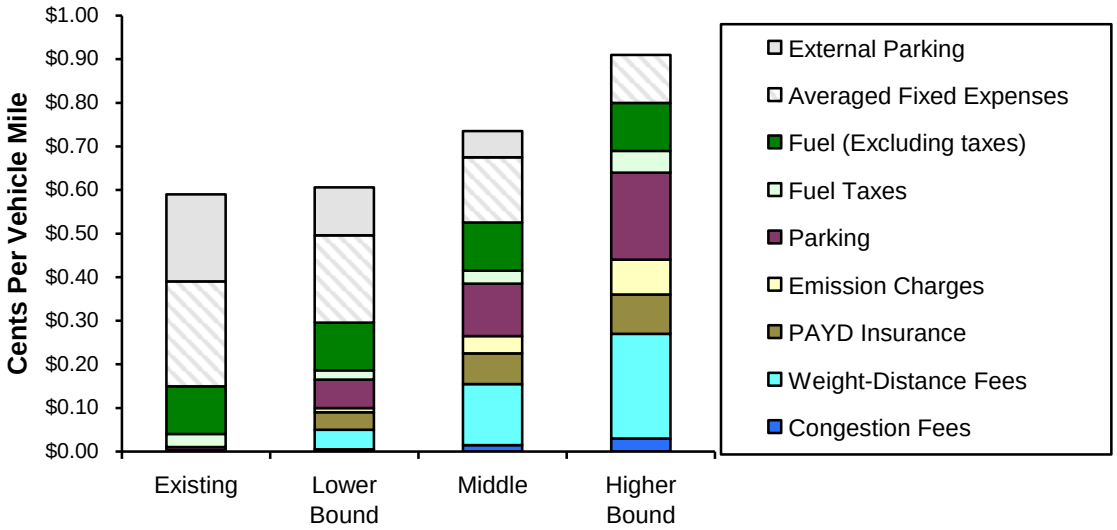
Table 13 **Optimal Pricing Summary – Middle-Range Values** (Average Per Vehicle-Mile)

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*
Total	*$0.015*	*$0.140*	*$0.070*	*$0.040*	*$0.120*	*$0.030*	*$0.415*
Share of Total	*3.6%*	*33.7%*	*16.9%*	*9.6%*	*28.9%*	*7.2%*	*100.0%*

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

Figure 11 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.[1]

Figure 11 **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 located farther from their final destination.

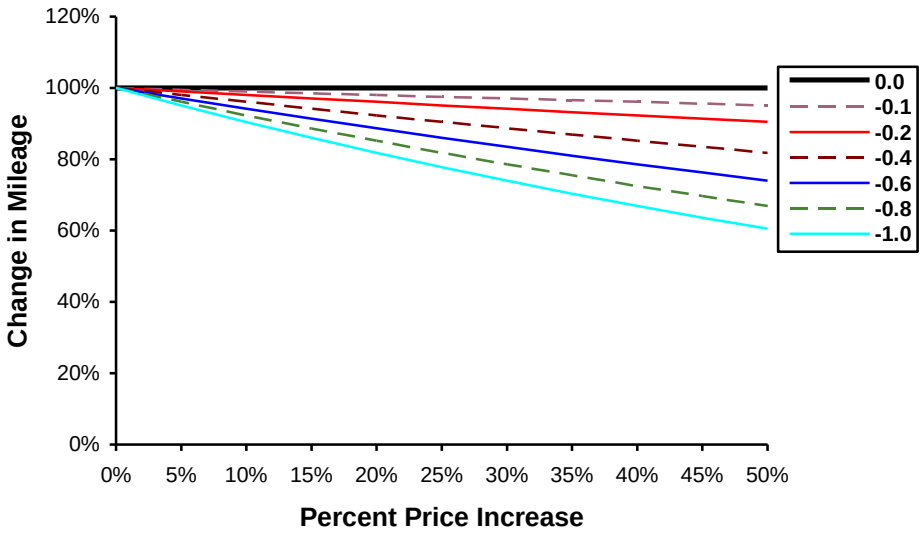
[1] Zhang and Lu (2012) estimate that optimal vehicle fees would average 7.7¢ to 9.1¢ per vehicle mile, including congestion, infrastructure deterioration and pollution emissions, but not including roadway capital costs, parking subsidies, accident externalities or noise pollution.

Travel Impacts

More efficient transport pricing is likely to change travel behavior in various ways, 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).

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. However, there is considerable variation, depending on specific conditions (Litman, 2004a).

Figure 12 **Mileage Changes Due to 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 increase 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).

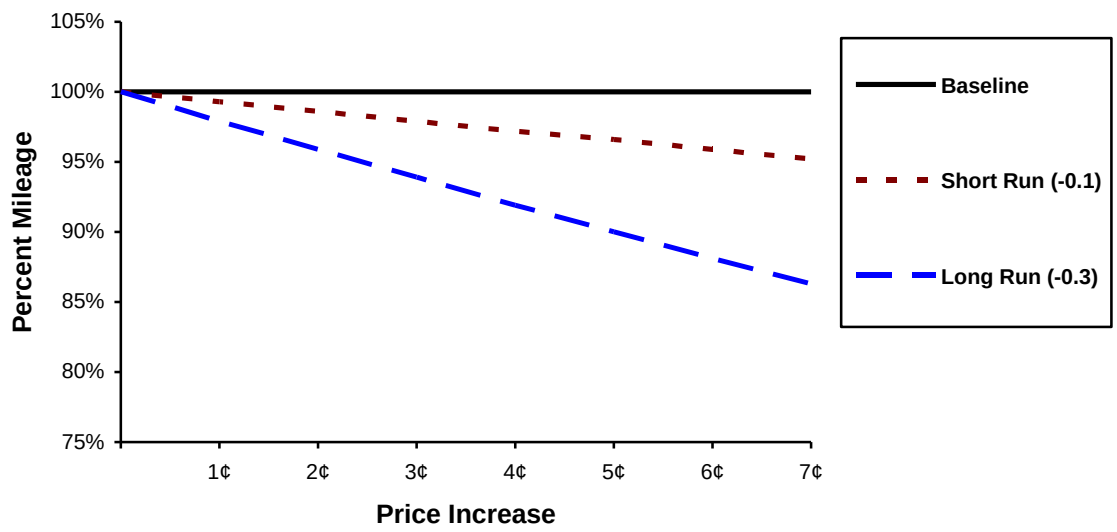
Large price changes have declining marginal impacts because they affect travel with higher consumer value. Arc elasticities reflect the change in consumption resulting from each 1% price

change. This can be calculated as [(1-*e*) x (1-*e*) x (1-*e*) …], 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% x 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 13.

Figure 13 **Mileage Reduction From Price Increases**



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

Table 14 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 14 **Vehicle Travel Reductions – Middle-Range Cost Values**

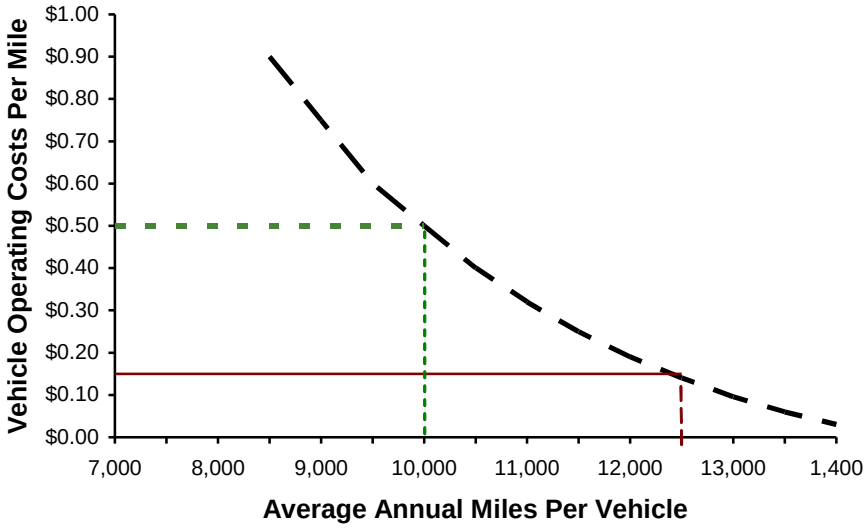
	Existing Fees	Optimal Fee	Fee Increase	Individual Reduction	Cumulative Reduction
Road Tolls	$0.003	$0.015	$0.012	1.7%	1.73%

Weight-Distance	$0.000	$0.140	$0.140	19.5%	20.87%
Distance-based 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%
Totals	*$0.149*	*$0.525*	*$0.376*		*43.21%*

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

Figure 14 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. Similarly, Zhang and Lu (2012) estimate that more efficient pricing would reduce automobile travel about 27%, although they only considered a limited set of external costs.

Figure 14 **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.

Total Impacts – Planning and Pricing Reforms

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
Transport options. **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 modes, and information about those options.	Least-cost planning and related reforms are estimated to reduce automobile travel 10-30%.
Optimal Planning. **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 *least-cost* transport planning practices.	More neutral policies and planning practices are estimated to reduce automobile travel 5-10.
Efficient pricing. **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%.

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

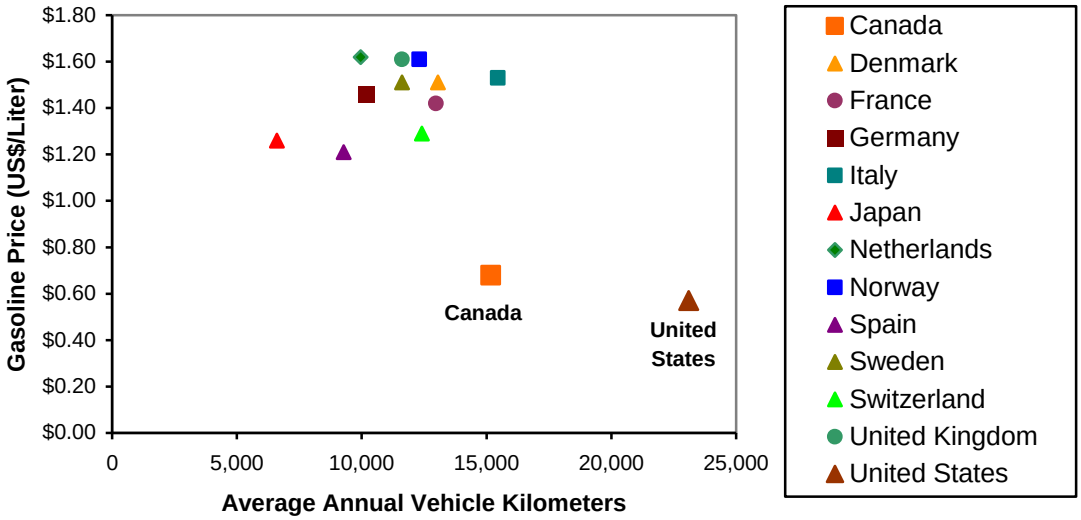
These reforms have interactive effects, so their impacts cannot simply be added. On one hand, marginal effects tend to decline as more reforms are implemented. It is therefore wrong to assume, for example, that because a 1¢ per vehicle-mile fee reduces vehicle travel 1.4%, a 10¢ per vehicle-mile fee 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 synergist impacts tend to be particularly large as transportation and land use patterns shift.

This analysis suggest that in a more optimal market, with improved accessibility options, more neutral planning and efficient pricing, 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%. Land use reforms are likely to cause typical households to shift to home locations that reduce automobile travel by 5-15%. Safirova, Houde and Harrington (2007) reached similar conclusions, although their analysis did not include all of the pricing distortions evaluated in this paper.

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 15 compares annual per 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 15 **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 reduce many costs. The table below summarizes projected impacts and savings, using the unit costs illustrated in Figure 8. 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. Extra large reductions (twice proportionate) would occur 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%
Totals		*$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. 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.

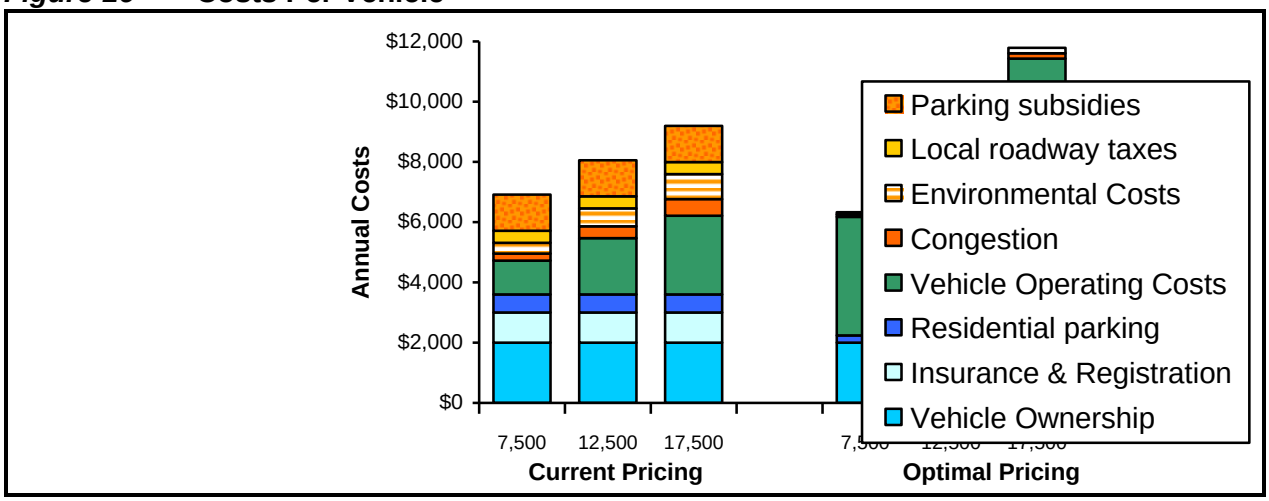
Consumer Impacts

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 16 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 16 **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 to provide additional beneficial services they can offer 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 (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 ("Economic Development," VTPI 2008). 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.

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 valuable vehicles and large-lot homes. This forces peers to purchase equally costly vehicles and homes to maintain their social position. To the degree that people choose these for the sake of prestige rather than 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 that significant increases in mobility provide 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). 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 improve 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 justify 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 *marginal external benefits* (you don't benefit if your neighbor increases their mobility).
Reforms, such as increased road and parking fees, would harm lower-income people.	Underpricing driving is an inefficient way to help poor people since they tend to drive less, use alternatives more, and bear many external costs than wealthier households. More targeted subsidies suitable for any mode are more efficient and fair.
Since the motor vehicle and fuel industries are major economic sectors, reduced vehicle and fuel consumption would be 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 or parking pricing revenues and cost savings would be squandered by governments or caputured 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. Vehicle fees and taxes are better than most other government funding options 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. However, 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 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 exernal 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. Price 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 amont 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 and fair. 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 and health 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 mobile 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. Lower income citizens 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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This study builds on extensive research concerning transportation economics, pricing, costs and planning reforms. To control its size and improve its readability, this report only cites a small portion of the hundreds of original documents upon which it is based. This paper relies on other documents that contain detailed reviews of individual subjects, particularly "Transportation Cost And Benefit Analysis" (Litman, 2008) and Vermeulen, et al (2004), which provide extensive information on transportation costs. The "Online TDM Encyclopedia" (VTPI, 2008) and van Essen, et al (2004), provide detailed information on transportation policy and pricing reforms. These documents contain more detailed discussion and extensive references.

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