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Critical Analysis of Conventional Transport Economic Evaluation

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Abstract
Transportation economic evaluation quantifies and monetizes transport project's benefits and costs. It can significantly influence planning decisions. This report critically examines conventional transport economic evaluation. It integrates two different but overlapping perspectives: planners interested in comprehensive and multi-modal transport system analysis and economists interested in economic efficiency and economic development impacts. This analysis indicates that conventional transport economic evaluation fails to reflect basic economic principles including comprehensive and neutral analysis, economic efficiency, consumer sovereignty and integrated decision-making. It evaluates transport system performance based primarily on vehicle travel speeds and operating costs, and overlooks other accessibility factors such as the quality of other modes, transport network connectivity and geographic accessibility. It overlooks many significant impacts including parking costs, vehicle ownership costs, mobility for non-drivers, public fitness and health, and the incremental costs of induced vehicle travel. These omissions and biases tend to favor mobility over accessibility and automobile travel over other modes. Theoretical and empirical evidence indicate that these distortions often reduce economic productivity. More comprehensive and multi-modal evaluation can provide better guidance for transport planning and economic development.

Introduction

Transportation economic evaluation refers to various methods and computer programs used in transport planning to quantify and *monetize* (measure in monetary units) the *impacts* (benefits and costs) of a transport policy or project. The assumptions and methods used in such evaluations can significantly affect planning outcomes: a policy or project may seem beneficial and desirable evaluated one way but harmful and undesirable evaluated another way.

Economic evaluation often includes *economic impacts analysis* which evaluates *economic development* impacts such as changes in business activity, productivity, employment, income, property development and tax revenues (Ellis, Glover and Norboge 2012). Economic development can provide dispersed benefits and so is often considered worth of public support and subsidy. Economic development results from producer (business) savings and efficiencies. Consumer savings, such as personal travel time savings, are *economic benefits*, but generally provide no direct *economic development benefits*.

Conventional transport economic evaluation methods originally developed to answer relatively simple questions, such as whether a highway project can repay its construction costs through travel time and vehicle operating cost savings. They consider a relatively narrow range of modes, objectives, impacts and transport improvement options, leading to biased results. To their credit, many transport modelers, planners and economists are working to improve evaluation methods by developing more integrated models that incorporate more impacts. However, these improvements are incremental, there are still significant gaps and biases even in the best transport evaluation models. It is important that people who use evaluation results understand these omissions and biases.

This is a timely issue. Current demographic and economic trends are changing future travel demands, and the scope of modes, objectives, impacts and options considered in transport planning is expanding. These trends require more comprehensive and multi-modal evaluation to identify the policies and projects that best meet future needs.

This report investigates these issues. It critically examines transport economic evaluation methods, identifies their omissions and biases, and discusses how these are likely to affect transport policy and planning decisions. It bridges the two different but overlapping disciplines: planners interested in comprehensive evaluation that responds to changing community demands, and economists interested in applying economic principles such as consumer sovereignty and economic efficiency. This critique should be of interest to anybody involved in transport planning, economic evaluation, or who uses the results.

Conventional Economic Evaluation

Conventional transportation economic evaluation uses various computer programs to quantify and *monetize* (measure in monetary units) the economic impacts (changes in travel time, vehicle operating costs, accidents, and emissions, etc.) caused by transport system changes (FHWA 2012; Markow 2012; SHRP 2012; TEC 2012).

Figure 1 **Typical Benefits and Costs Distribution by Stakeholder Group** (FHWA 2012)

User	Societal	Agency
Travel time Travel time reliability Safety Vehicle operating costs Fuel costs Comfort/convenience (Costs)	Environmental/emissions Health Mobility Productivity Security	Efficiency Productivity (Costs)

Conventional transport evaluation considers a relatively limited set of impacts. Vehicle ownership and parking costs, mobility for non-drivers and public fitness impacts are overlooked.

Table 1 summarizes the analysis scope of various transportation evaluation tools. Although none is truly comprehensive, some newer programs (TREDIS, PECAS and RUBMRIO), consider a broader range of impacts. For example, car ownership and parking costs are now recognized and can be modeled with TREDIS and REMI (Weisbrod and Reno 2009).

Table 1 **Transport Economic Evaluation Tools** (Ellis, Glover and Norboge 2012)

						BEA	EDR	TTI		FHWA												UT			
	AASHTO MANUAL	CDSS	EMME3	IMPLAN	REMI	RIMS II	TREDIS	HEEM-III	MicroBENCOST	HERS-ST	TELUS	TELUM	FHWA HWY 1	SCRITS	SMITE	SPASM	STEAM	REIMHS	REIMS	MEPLAN	PECAS	RUBMRIO	HEAT	TBM	LEAP
TYPE OF PROJECT USED FOR:																									
Upgrade Existing	x						x	x	x	x	x	x			x						x				
Maintain Existing							x	x	x								x	x			x	x			
New Construction	x						x	x	x		x	x				x	x	x		x	x	x	x		
SCALE:																									
Specific Site				x								x				x				x					
Specific Corridor	x							x	x	x	x	x			x	x	x	x							
Region						x		x		x	x	x	x				x				x	x	x		
USER IMPACTS:																									
Money cost of travel	x							x	x	x	x				x			x			x		x		
Travel time	x	x	x				x		x	x	x					x	x						x		
Safety	x						x		x	x				x			x								
Comfort																									
Traffic volumes and average speed			x				x			x				x			x								
Calculation of delay savings							x										x				x		x		
Accident reduction savings	x							x	x	x															
Calculation of motorist benefits over the analysis period							x	x													x				
Highway improvement cost	x									x					x	x		x			x		x		
Summary of benefits and costs	x						x	x		x				x	x	x					x		x		
ECONOMIC IMPACTS:																									
Employment					x		x				x	x	x							x	x	x	x		
Wages		x			x		x				x	x	x							x	x	x	x		
Property values, prices or rents	x											x								x	x	x	x		
Business sales volume						x	x															x	x		
Value added						x	x				x									x					
Business profit						x															x	x	x		
Improved efficiency in public and private services															x	x	x			x		x	x		
Health and safety improvements														x											
Tourism spending			x																				x		
Number of establishments (new, existing, dislocated)												x										x			
Population/growth rate																									
Capital investment						x									x		x			x	x		x		
Building permits, construction activity																							x		
Value of oil and gas production																									
Usable parking spaces																									
Number of customers per day																									
Parking capacity influences on gross sales impacts																									
GOVERNMENT FISCAL IMPACTS																									
Public revenue/ taxes					x	x	x				x						x	x			x	x			
Public expenditures					x											x				x	x	x			
OTHER IMPACTS:																									
Air quality	x				x											x	x								
Social conditions	x				x		x							x	x					x	x	x			

This table summarizes various tools used to evaluate transport policy and project economic impacts. Note that many (CDSS, HEEM-III, LEAP, MicroBenCost, REIMHS, REIMS and SPASM) are outdated and should not be used, others (SMITE, SCRITS and Highway 1) are very specialized, HEAT is an example of a state-specific REMI shell program (other states have similar versions) and EMME3 is an example of a travel demand forecasting model, not an economic model.

The box on the following page describes the general capabilities and limitations of the various types of models.

Choosing Economic Analysis Software – Overview of Model Tools
Glen Weisbrod (2003), Economic Development Research Group (www.edrgroup.com)

Input-output (I-O) models calculate the economic development impacts (jobs, income and GDP) resulting from changes in regional business activity. For instance, they can be used to calculate the impacts of a new or expanded airport, power plant or construction activity. However, they have no long-term forecasting dimension, and no internal ability to forecast impacts of changes in transport costs or market access. For the US, the most commonly used RIMS-II and IMPLAN. For Canada, Statistics Canada offers provincial level models. More specialized models are also available.

Economic impact forecasting models are more comprehensive evaluation tools that calculate changes in business attraction as well as growth. They incorporate I-O models and add capabilities to calculate the economic growth consequences of changes in household and business costs (due to travel time and travel cost changes). Newer ones also calculate impacts of changes in market access and trade over time. For the US and Canada, the most commonly used are REMI and TREDIS. Both are multi-regional, spatial economic models that can also tax revenue impacts and social benefit-cost measures. Other models with more limited or specialized uses are also available.

Land use models forecast change in the location patterns of population, employment, housing and business activities. The newer versions are sometimes referred to as *spatial input-output models* because they base their allocation of business growth on I-O models, with greater spatial detail and less industry detail. They account for market access but not business attraction, because they assume fixed regional growth. The most widely used are PECAS and UrbanSim.

User benefit/cost models are designed to help engineers and planners identify, rate and select optimal highway projects. They assess highway improvement benefits travel speed and delay, safety, and sometimes emissions rates. They do not consider economic development impacts, although some of their impacts are incorporated into forecasting models. BCA.net provides project level analysis. HERS-ST assesses statewide highway investment needs and project priorities. LCCA evaluates facility lifecycle costs. Other widely recognized benefit-cost tools used by state DOTs are CalBC and NetBC. A variety of other transportation planning tools are also available.

Economic development tools are models and datasets designed to assist in business attraction and site location decisions. BizCosts, LocationSelector and FacilityLocations, Site Selector Pro and LEAP all compare alternative locations in terms of business operating costs, market conditions, labor force, land, transportation access, etc. They can assist businesses in making site location decisions for new facilities, and economic developers can use them to identify relative their area's strengths, weaknesses and best targets for business attraction. They generally consider transportation access in limited terms, such as distance to nearest interstate highway and airport.

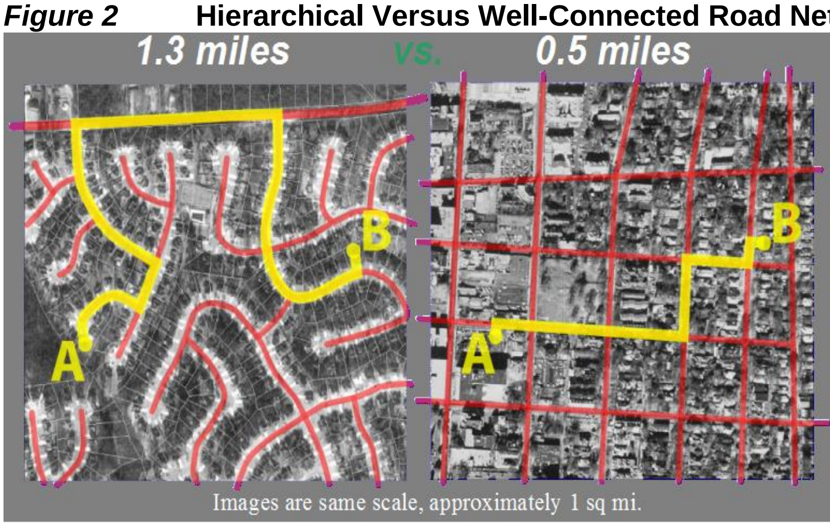
Mobility- Versus Accessibility-Based Planning

Conventional transport evaluation often assumes that *transportation* refers simply to *mobility* (physical movement) and so evaluates transport system performance using indicators such as average travel speed, congestion delay, and costs per-mile or -kilometer. More comprehensive and multi-modal planning recognizes that the ultimate goal of most travel activity is *access* to services and activities (CTS 2010; Litman 2003). Several factors can affect accessibility:

- *Motor vehicle travel conditions*. Automobile travel speeds, affordability and safety.
- *Quality of other modes*. Walking, cycling, public transit, telework, delivery services speeds, convenience, comfort, affordability and safety.
- *Transport network connectivity*. Density of paths and roadway connections, and therefore the directness of travel between destinations, plus the quality if connections with public transport.
- *Land use proximity*. Development density and mix, and therefore distances between activities.

Planning decisions often involve tradeoffs between different forms of accessibility. For example, roadway design features intended to increase automobile accessibility, including wider roadway with higher traffic speeds, and hierarchical road networks that have fewer intersections, allow higher vehicle travel speeds, but create barriers to pedestrian travel, and since most public transit trips involve walking links, reduces transit access, and increase travel distances, as illustrated below. Locations convenient for automobile access, such as major highway intersections, tend to be difficult to access by other modes, while more central locations that are easier to access by walking and transit often have more intense traffic and parking congestion.

Figure 2 **Hierarchical Versus Well-Connected Road Networks**



Hierarchical road networks (left) have numerous dead-end streets that connect to higher-speed arterials. This lengthens trip distances and concentrates traffic on a few roads, which tends to increase congestion. A well-connected road network (right) offers multiple, direct routes between destinations, which reduces trip distances and distributes traffic. Well connected road networks often have lower average speeds but total travel times are generally less.

Table 2 summarizes the degree that conventional transport economic evaluation considers various accessibility factors, and requirements for more comprehensive evaluation. Conventional evaluation primarily considers automobile and public transit travel speeds, but gives little consideration to non-motorized travel conditions, and if transport network connectivity and land use accessibility are considered at all, it is only at a regional scale.

Table 2 **Consideration of Accessibility Factors In Transport Planning Evaluation**

Factor	Consideration in Conventional Evaluation	Required for Comprehensive Evaluation
Motor vehicle travel conditions – traffic speed, congestion delays, vehicle operating costs and safety	Usually considered using indicators such as roadway level-of-service, average traffic speeds and congestion costs and crash rates.	Impacts should be considered per capita (per capita vehicle costs and crash casualties) to take into account the amount that people travel.
Quality of other modes – convenience, comfort, safety and affordability of walking, cycling, ridesharing public transport	Considers public transit speed but not comfort. Non-motorized modes ignored.	Multi-modal transport system performance indicators that account for convenience, comfort, safety, affordability and integration
Transport network connectivity – density of connections between paths, roads and modes, and therefore the directness of travel between destinations	Traffic network models consider major regional road and transit networks. Local streets, non-motorized networks (paths and sidewalks), and connections between modes are often ignored.	Fine-grained analysis of sidewalk, path and road network connectivity, and consideration of the connections between modes, such as the ease of walking and biking to public transit terminals.
Land use proximity – density and mix, and therefore the distances between activities	Often ignored. Some integrated models consider some land use factors.	Fine-grained analysis of how land use factors affect accessibility by various modes.

Conventional planning evaluates transport system performance based primarily on motor vehicle travel speed and operating costs. New methods are needed for more comprehensive accessibility evaluation.

Often-overlooked accessibility factors are frequently significant. Various types of research indicate that vehicle traffic speeds influence overall accessibility less than the quality of transport options, roadway connectivity and land use accessibility. For example, a major U.S. study found that development density has about ten times more influential on the number of destinations that can be reached in a given time period than the same percentage increase in vehicle traffic speeds (Levine, et al. 2012). Another major study found that in Phoenix, Arizona, residents of more central neighborhoods make substantially shorter trips, drive a third fewer daily miles and experience less congestion delays their suburban counterparts due to their improved travel options, more connected streets and increased proximity to destinations (Kuzmyak 2012).

The Texas Transportation Institute (TTI) estimates that in large U.S. cities, congestion increases average annual commuting costs by 34 hours and 16.5 gallons of fuel. In contrast, residents of more automobile-dependent U.S. urban regions such as Jacksonville, Nashville and Houston average more than 30 daily vehicle miles traveled, over 50% more than the 20 vehicle miles traveled in compact, multi-modal communities such as New York, Sacramento and Portland. This additional driving adds 104 additional hours and 183 gallons of fuel per capita on average, far more than per capita congestion delays (Litman 2012).

These and other studies illustrate the importance of evaluating transport system performance based on accessibility rather than just mobility. Mobility-oriented evaluation favors policies and projects that increase vehicle travel speeds without regard to other accessibility factors. It overvalues roadway expansion and undervalues alternative modes, demand management strategies and smart growth policies.

Economic Principles

This section discusses basic economic principles that should guide economic evaluation.

Comprehensive and Neutral Analysis

Accurate evaluation must consider all significant impacts (benefits and costs). One way to determine which impacts should be considered is to start by defining planning objectives (specific conditions that a community wants to achieve, such as reduced congestion and improved public fitness and health). Table 3 indicates the degree that common planning objectives are considered in conventional transport economic evaluation.

Table 3 **Consideration of Objectives in Transport Economic Evaluation**

Objective	Consideration In Conventional Evaluation
Congestion reduction	Generally considered. Often dominant
Roadway cost savings	Generally considered
Parking cost savings	Often ignored in transport planning but considered in other types of planning
User cost savings & affordability	Vehicle operating costs and transit fares usually considered, vehicle ownership costs often ignored.
Improved mobility for non-drivers	Generally ignored in major roadway planning, but recognized in urban street and transit planning
Traffic safety	Generally considered, but measured per vehicle-mile,
Energy conservation	Sometimes considered, but measured per vehicle-mile
Air emission reductions	sometimes considered, but measured per vehicle-mile
Efficient land use	Not generally considered in individual transport plans
Public fitness and health	Not generally considered in individual transport plans

Only a portion of common transport planning objectives are considered in conventional evaluation. Some impacts are measured per unit of travel which ignores the incremental costs of induced vehicle travel.

Table 4 indicates the impacts that are typically included or overlooked in conventional economic evaluation. Overlooked impacts are sometimes called *intangibles*, with the implication that they are difficult to monetize and insignificant in magnitude. However, many of these impacts have been monetized and are significant in magnitude (Litman 2009). For example, UK and New Zealand transport agencies have standard methods for monetizing parking costs, habitat preservation, changes in mobility options for disadvantaged people, and changes in public fitness and health caused by transport planning decisions (DfT 2006; NZTA 2010).

Table 4 **Conventional Transport Evaluation Scope of Monetized Impacts**

Usually Considered	Often Overlooked
Financial costs to governments	Downstream congestion
Travel speed (reduced congestion delays)	Parking costs
Vehicle operating costs (fuel, tolls, tire wear)	Delay to non-motorized travel (*barrier effect*)
Per-mile crash risk	Vehicle ownership and mileage-based depreciation
Project construction environmental impacts	Indirect environmental impacts
	Strategic land use impacts
	Public fitness and health

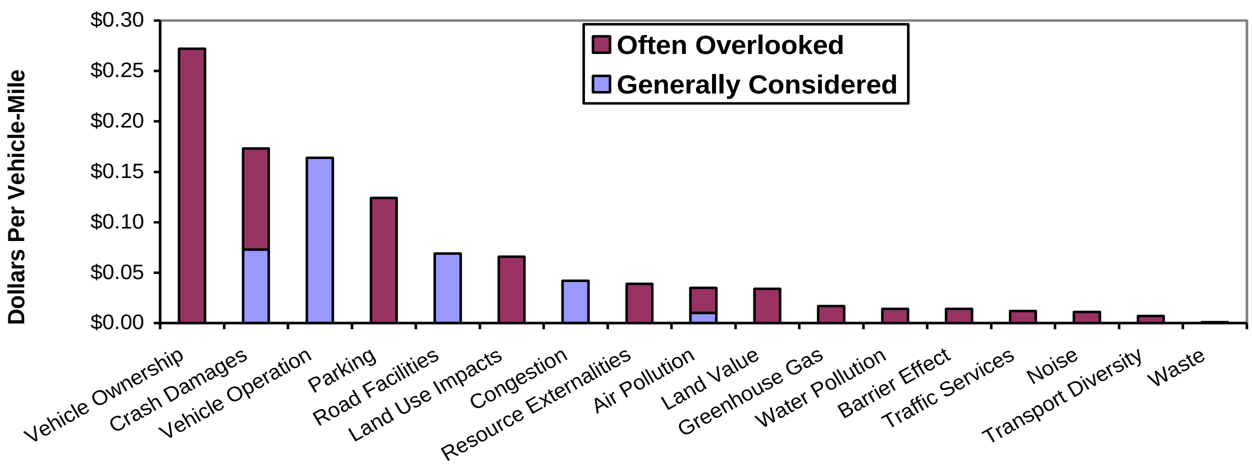
Conventional transportation economic evaluation tends to monetize a limited set of impacts.

Since congestion costs often dominate conventional transport economic evaluation it is important to consider the accuracy of these values. Congestion costs are usually measured by comparing vehicle travel speeds and operating costs between peak and freeflowing conditions (i.e., level-of-service A), and monetizing increased travel times and fuel consumption. Many economists believe that this approach exaggerates congestion costs by using freeflow speeds as a baseline, and unit travel time values that are higher than most motorists would willingly pay for travel time savings (Litman 2013; iTrans 2006). More realistic baseline and travel time values typically reduce congestion cost estimates by 40-60%. In addition, conventional evaluation often overlooks or undervalues generated traffic and induced vehicle travel, which tends to exaggerate the benefits and underestimates the full costs of urban roadway expansions (Litman 2001).

Several studies using various analysis methods indicate that per capita transport expenditures are higher in automobile-oriented communities that have more road and parking supply, and lower fuel and parking fees, than in more compact and multi-modal communities with higher vehicle operating costs, because lower costs per vehicle-mile are more than offset by increased vehicle travel (Makarewicz, et al. 2008; Litman 2008). Typical North Americans spend 350 to 550 annual hours and $4,000 to $6,000 annual dollars on vehicle travel, plus indirect costs including road and parking subsidies, accident and environmental damages. As discussed above, severe congestion adds about 35 travel hours and $60 in fuel expenses annual per capita, which is small compared with the incremental travel time and vehicle costs that can result from automobile-dependent transport systems and sprawled development. This suggests that conventional evaluation exaggerates the importance of congestion relative to total transportation costs.

Figure 3 illustrates estimates of various automobile costs, showing the portions that are typically considered and overlooked in conventional evaluation. Many significant costs are often overlooked. For example, conventional models ignore vehicle ownership and most parking costs, based on the assumption that transport planning decisions do not affect total vehicle ownership or parking demands. Such assumptions are inappropriate for evaluating alternative modes, demand management strategies or smart growth policies that often do affect these costs.

Figure 3 **Automobile Costs** (Litman 2009)



Conventional transport economic evaluation generally considers congestion, roadway, vehicle operation, and some accident and air pollution costs. Other impacts are generally overlooked.

Table 5 summarizes the scope of accessibility factors and economic impacts considered in conventional transport evaluation.

Table 5 **Conventional Transport Evaluation Accessibility Factors and Impacts**

		← Accessibility Factors →				
		Automobile	**Transit**	**Non-motorized**	**Road Connectivity**	**Proximity**
↑ Economic Impacts ↓	Travel speed and delay	Yes	Yes	No	Sometimes	Sometimes
	Safety and security	Yes	Sometimes	Sometimes	No	No
	Vehicle operating costs	Yes	Yes	No	No	No
	Vehicle ownership costs	No	No	No	No	No
	Energy consumption	Yes	Yes	Sometimes	No	Sometimes
	Pollution emissions	Yes	Yes	Sometimes	No	Sometimes
	Mobility for non-drivers	No	Yes	No	No	No
	User comfort	Yes (paved roads)	No	No	Not Applicable	Not Applicable
	Parking costs	No	No	No	No	No
	Land use impacts	No	No	No	No	No
	Public fitness and health	No	No	Sometimes	No	No

Conventional planning considers a limited scope of modes and impacts. More comprehensive and integrated planning considers additional modes, impacts and options, which requires additional data.

Table 6 visually illustrates these factors. Dark blue indicates impacts that are *usually* monetized, light blue indicates impacts that are *sometimes* monetized in transport economic evaluation, and white indicates impacts not generally included in transport economic evaluation.

Table 6 **Conventional Transport Evaluation Accessibility Factors and Impacts**

		← Accessibility Factors →				
		Automobile	**Transit**	**Non-motorized**	**Connectivity**	**Proximity**
↑ Economic Impacts ↓	Travel speed and delay					
	Safety and security					
	Vehicle operating costs					
	Vehicle ownership costs					
	Energy consumption					
	Pollution emissions					
	Mobility for non-drivers					
	User comfort					
	Parking costs					
	Land use impacts					
	Public fitness and health					

This table illustrates the scope of accessibility factors and impacts considered in convention evaluation models. Dark blue indicates fully monetized impacts. Light blue indicates partly monetized impacts.

This indicates that conventional evaluation overlooks significant accessibility factors and economic impacts. To be fair, the excluded factors and impacts are often considered at other stages in a planning process, such as through public engagement or programs to achieve specific objectives such as pollution reductions, but not in monetized economic evaluation.

Economic Efficiency

Economic efficiency refers to the overall benefits provided by goods and services. It recognizes variations in the value of travel to users and society. For example, a vehicle transporting an injured person to a hospital generally has more value than the same vehicle on the same road for less urgent travel. Freight, service and public transport vehicles generally have greater travel time costs than most personal vehicles. High occupancy vehicles are usually more space efficient (they carry more passengers per lane) than most automobiles. Economic efficiency increases if transport policies favor higher value trips and more efficient modes over lower value trips and less efficient modes. This can be done by regulation, for example, by giving emergency vehicles priority in traffic, special lanes for freight and high occupancy vehicles, and by pricing that allows higher value trips and more efficient modes to outbid other vehicles for scarce road space.

Consumer Sovereignty (Responding to Consumer Demands)

Consumer sovereignty refers to the degree that markets respond to consumer demands. This recognizes the consumer welfare benefits by a transport system which allows travelers to choose the options that best meet their needs for each trip. This implies that there are economic efficiency benefits from increasing transport system diversity, including additional modes, service qualities and pricing options, provided that some consumers would use those options and their costs to society are not significantly higher than existing options.

Transport demands are diverse. In a typical community 20-40% of residents cannot or should not drive due to age, disability or low-income, and current demographic and economic trends (aging population, rising fuel prices, urbanization, increased health and environmental concerns, etc.) are increasing demand for alternative modes. Walking and cycling and public transit tend to be more affordable and produce less external costs than automobile travel, particularly if these modes reduced the need to chauffeur non-drivers, since such trips often involve empty backhauls, so each useful passenger-mile generates two vehicle-miles. Improving transport options can support economic development, for example, by improving non-drivers' ability to access school and work, and by reducing traffic congestion and parking problems.

This suggests that there are potentially large consumer welfare gains and economic efficiency benefits from serving latent demand for resource efficient modes such as walking, cycling and public transit. Conversely, this suggests that there are significant costs to users and society from policies and planning practices which unintentionally favor automobile travel over these modes, resulting in a less diverse, automobile-dependent transportation system. However, conventional evaluation overlooks many of these impacts; it does not account for consumer sovereignty or other benefits of increased transportation system diversity.

System Efficiency – Strategic Planning Consistency

A fourth principle for economically efficient transport planning is the degree that planning is integrated, so individual short-term decisions support strategic, long-term goals. For example, if tourist industry development is a strategic regional goal, efficiency requires that individual transport and land use planning decisions support this goal as much as possible. Similarly, efficiency increases if land use development policies, such as minimum parking requirements in zoning codes and the location of public facilities such as schools, are effectively planned in conjunction with efforts to improve walking, cycling and public transit services.

This principle requires evaluating the overall efficiency of a system, rather than components individually. There is considerable variation in the degree that transport economic evaluation reflects system efficiency. Most urban regions have traffic models that evaluate roadway system efficiency, but there are often significant gaps in their ability to evaluate other modes, sectors or scales. For example, few regional transport models can provide information on how changes in pedestrian and cycling conditions affect public transit travel and traffic congestion, or how changes in parking requirements affect future development density and mode share. As a result, planning decisions are sometimes at cross-purposes, for example, regional transportation agencies may want to encourage transit-oriented development, but lack support from local jurisdictions that do little to improve walking and cycling conditions and impose generous parking requirements on new development.

Table 7 summarizes the degree that conventional planning reflects these four principles.

Table 7 **Economic Principles**

Principle	Requirement	Conventional Transport Planning
Comprehensive analysis	Evaluation considers all significant changes in accessibility factors and economic impacts.	Often considers a limited set of impacts related primarily to automobile travel. Often ignores the negative impacts that roadway expansion and hierarchical road networks have on alternative modes, transport networks connectivity and land use proximity. Generally ignores the incremental costs of induced vehicle travel and sprawl. Generally ignores impacts on vehicle ownership costs, parking costs, and public fitness.
Economic efficiency	Recognizes that some modes are more resource efficient, and some trips have higher value than others.	Not generally considered. Seldom considers the full benefits of policies and projects that favor more efficient modes and higher value trips.
Consumer sovereignty	Recognize the value of serving diverse consumer demands, particularly resource-efficient travel options that serve non-drivers.	Overlooks many benefits of serving currently latent travel demands, including consumer welfare, affordability and reduced external costs.
System efficiency	Planning is integrated between sectors, jurisdictions and agencies, so individual, short-term decisions support strategic, long-term goals	Conventional planning is often uncoordinated, resulting in conflicting decisions.

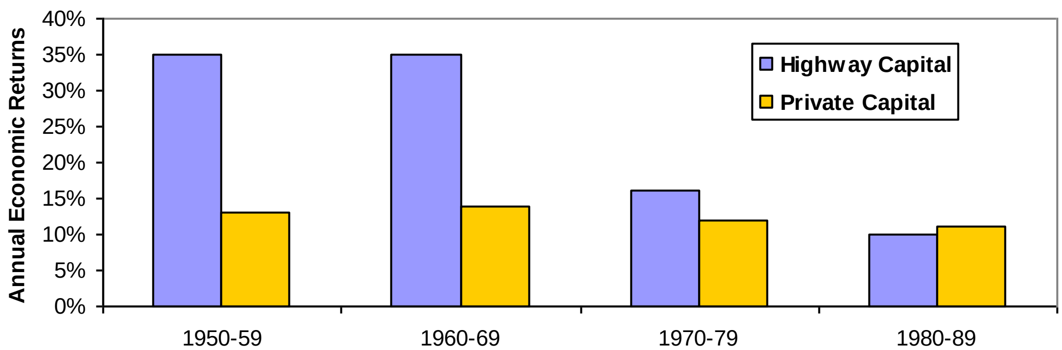
Conventional transport evaluation fails to reflect many efficiency principles.

Economic Development Impact Evaluation

Economic evaluations often give special priority to economic development impacts which affect productivity, employment, incomes, property development and tax revenues. Economic development is considered to provide external benefits and so deserves public support. However, conventional transport project evaluations and specialized *economic impact studies* often exaggerate economic development benefits by including economic transfers (such as funding provided by other levels of government) as economic benefits, and assuming that personal travel time savings increase economic productivity (Crompton 2006).

Transportation projects can support economic development by increasing *producer* (business and government) efficiency. In competitive markets even modest transport efficiency gains can provide significant economic development benefits. Port, railway and intermodal freight facility improvements, and roadway congestion pricing, can provide large productivity gains by reducing shipping costs. The first paved road to an area, or improved passenger transport to areas with undeveloped tourism potential, can support economic development. However, once an area has a basic road system, expansions often provides modest economic development impacts (Shatz, et al. 2011). Since 90% or more of urban-peak roadway traffic consists of personal vehicles, urban roadway expansions primarily benefit consumers, not producers. Although personal travel time savings are *economic benefits*, they do not increase *economic development* which can benefit other community members (besides users of the expanded roadway). If highway expansions induce additional vehicle travel they can reduce economic development by increasing various external costs, and vehicle and fuel expenditures which generate less business activity and employment per dollar than most other consumer expenditures (Litman 2010; SACTRA 1999). Figure 4 illustrates the declining return on U.S. highway investments estimated in one study.

Figure 4 **Annual Highway Rate of Return** (Nadiri and Mamuneas 2006)

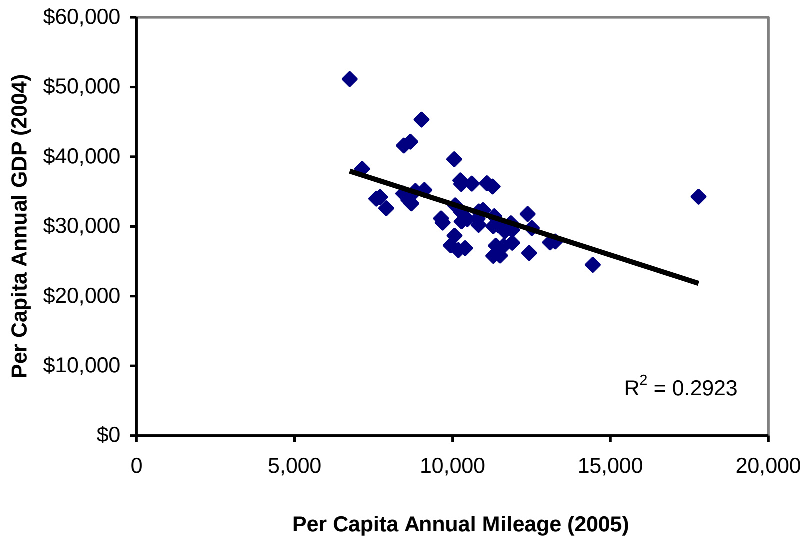


Highway investment provided high economic returns during the 1950s and 60s when the Interstate system was first developed, but have since declined, suggesting that highway expansion is now a poor investment.

Many economic benefits identified in economic impacts studies are transfers not true efficiency gains. For example, economic impact studies often consider a transport project's wages and new property development to be benefits, and this may be true for a particular employee, business, property owner or region, but they are actually economic transfers. Project funders (often governments) pay wages, and property investments may have occurred elsewhere in the region had the roadway project not occurred. Economic transfers do not increase overall productivity.

Theoretical and empirical evidence indicate that beyond an optimal level, excessive motor vehicle travel reduces economic development. Within developed countries there is a negative relationship between vehicle travel and economic productivity as illustrated in the following figures (also see Kooshian and Winkelman 2011).

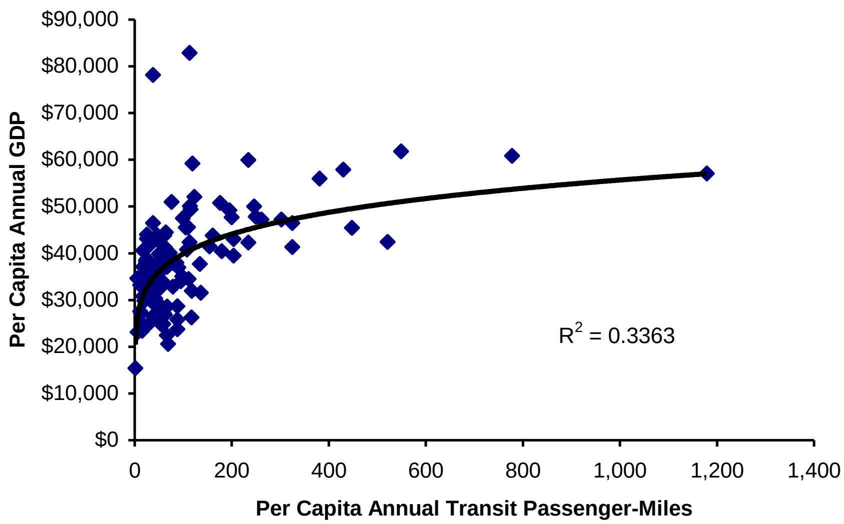
Figure 5 **Per Capita GDP and VMT for U.S. States** (VTPI 2009)[1]



Per capita economic productivity increases as vehicle travel declines. (Each dot is a U.S. state.)

Similarly, *GDP tends to increase with public transit travel*, as illustrated in Figure 6.

Figure 6 **Per Capita GDP and Transit Ridership** (VTPI 2009)

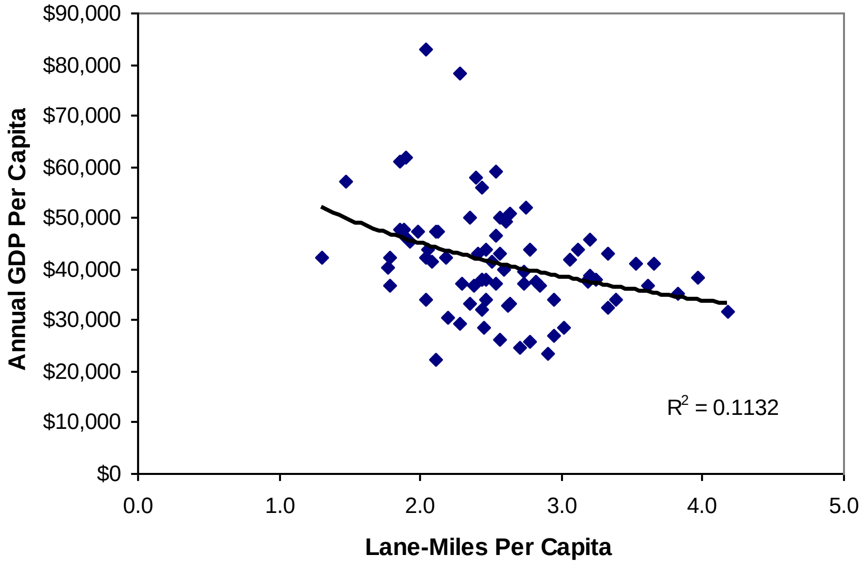


GDP tends to increase with per capita transit travel. (Each dot is a U.S. urban region.)

[1] This and subsequent graphs are based on the *2009 Urban Transportation Performance Spreadsheet* (www.vtpi.org/Transit2009.xls). Also see Litman 2010.

Per capita GDP tends to decline with roadway lane miles, as illustrated in Figure 7. Zheng, et al. (2011) find similar results: per capita economic productivity tends to be higher in states with less automobile-dependent transport systems.

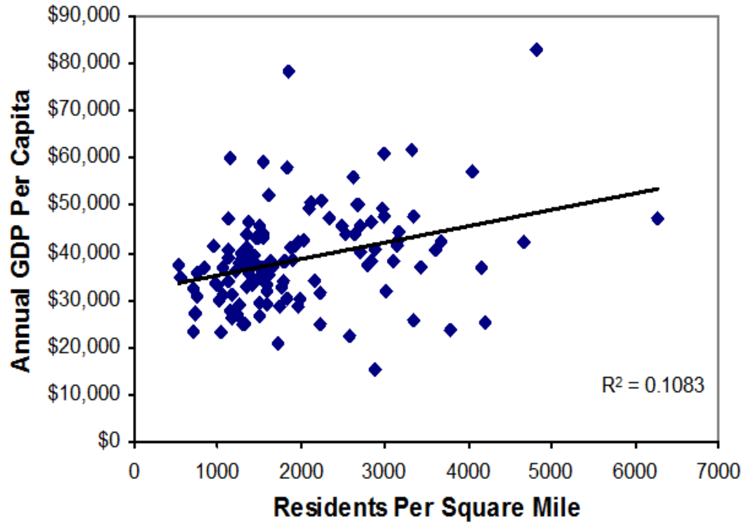
Figure 7 **Per Capita GDP and Road Lane Miles** (VTPI 2009)



Economic productivity declines with more roadway supply, an indicator of automobile-oriented transport and land use patterns. (Each dot is a U.S. urban region.)

Per capita GDP tends to increase with population density, as illustrated in Figure 8, probably due to a combination of agglomeration efficiencies and increased transport system diversity.

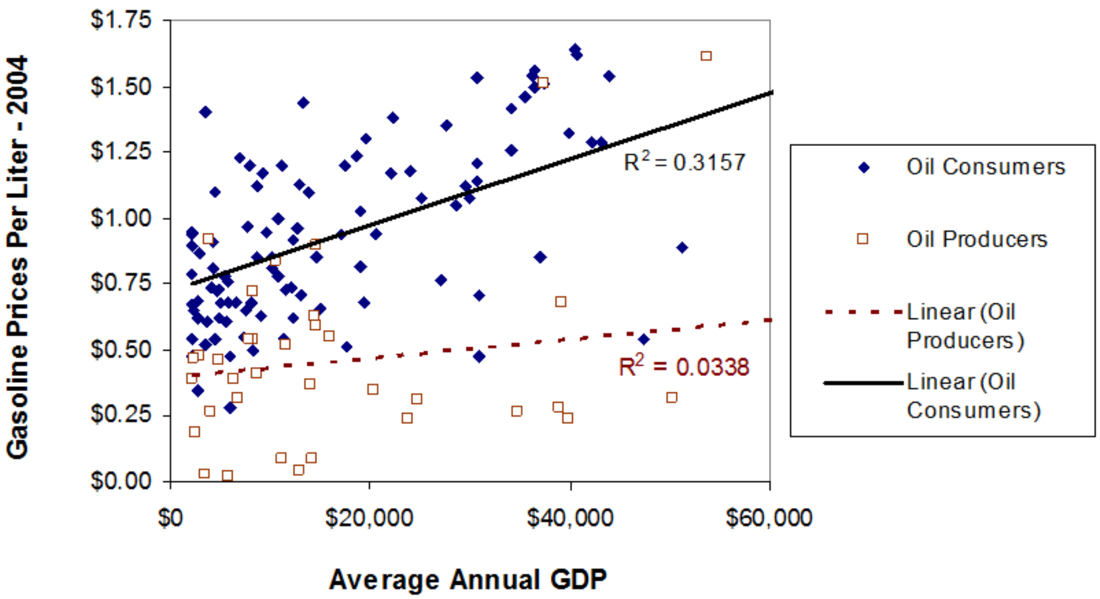
Figure 8 **Per Capita GDP and Urban Density** (BTS 2006 and BEA 2006)



Productivity tends to increase with population density. (Each dot is a U.S. urban region.)

Figure 9 shows that per capita GDP increases with fuel prices, particularly among oil importing countries ("Oil Consumers"). This suggests that high fuel prices support economic development by encouraging transport system efficiency and reducing domestic wealth lost to fuel importation. This suggests that, although a certain amount of mobility supports economic development, the high levels of vehicle travel common in many affluent countries are economically excessive, which reduces productivity.

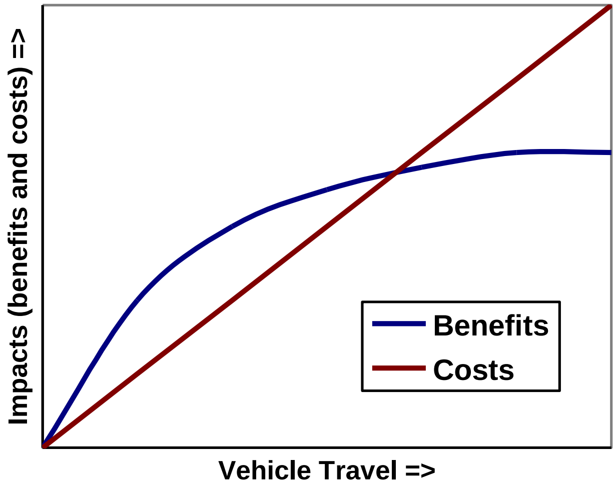
Figure 9 **GDP Versus Fuel Prices, Countries** (Metschies 2005)



Economic productivity tends to increase with higher fuel prices, indicating that substantial increases in vehicle fees can be achieved without reducing overall economic productivity.

Basic economic theory can explain these results. Motor vehicle transport is costly, including costs of vehicles, fuel, roads and parking facilities, accident and pollution damages. Although a certain amount of vehicle travel provides large benefits, mobility, like other economic inputs, tends to have declining marginal returns because rational consumers choose more beneficial travel over less beneficial travel. For example, if a person can only afford to drive 4,000 annual miles, they will reserve vehicle travel for high value trips. If that person can afford to drive 8,000 annual miles, the additional travel will probably be less beneficial, since they already satisfied their most important vehicle trips. If they can afford 12,000 annual miles, the additional vehicle travel is likely to provide even smaller marginal benefits. As a result, if people drive high annual miles, a significant portion of that travel probably has modest user benefits, either because the travel itself has low value or because it could be done in other ways with modest incremental costs, such as shifting to walking, public transit or telecommunications. Yet, vehicle travel costs (including internal and external costs) increase approximately linearly. As a result, if motor vehicle travel is underprice a significant portion may be economically inefficient, with incremental costs that exceed incremental benefits, as illustrated in Figure 10.

Figure 10 **Motor Vehicle Benefits and Costs**



Some vehicle travel provides large consumer and productivity benefits, but as mobility increases the additional vehicle travel tends to provide declining marginal benefits. Costs increase linearly. If vehicle travel is underpriced due to inefficiently priced roads, parking, accident risk and pollution emissions, a significant portion of vehicle travel may have costs that exceed benefits.

Conventional transport economic evaluation can inaccurately measure economic development impacts in the following ways.

- By treating economic transfers as resource savings and benefits.
- By assigning productivity gains to consumer savings.
- By exaggerating congestion cost savings.
- By overlooking the increased external costs (downstream congestion, increased parking subsidies, accident and environmental damages, reduced accessibility by other modes) associated with induced vehicle travel.
- By overlooking the economic costs of increased consumer expenditures on vehicles and fuel.

For example, the documents, *Assessing the Economic Benefit of Transportation Infrastructure Investment in a Mature Surface Transportation System* (Cambridge Systematics 2012) and the *Operations Benefit/Cost Analysis Desk Reference* (FHWA 2012) reflect conventional thinking about these issues. These documents reflect mobility-based assumptions: that *transportation* means travel; that the greatest transportation problem is traffic congestion; that the main way to improve transport economic productivity is to increase travel speeds; and the main external costs of transportation are pollution and uncompensated accident risk. As a result, the analysis ignored the possibility that conventional transport projects (such as roadway expansions and roadway access management) may reduce other forms of accessibility and increase transport costs, and that pricing reforms may provide similar or greater productivity gains by favoring higher-value travel and more space-efficient modes.

Example

As previously described, conventional evaluation often has these omissions and biases:

- Ignores consumer welfare gains and social benefits from serving latent demand for resource efficient modes (walking, cycling and public transport).
- Ignores efficiency gains from giving priority to higher value trips and more efficient modes.
- Ignores negative effects that roadway expansion can have on other accessibility factors.
- Applies exaggerated congestion cost values.
- Ignores or underestimates generated and induced travel, and so does not account for increased downstream congestion, increased parking demand.
- Primarily evaluates alternative modes based on their ability to reduce vehicle traffic congestion, and so places little benefit on improved convenience and comfort to existing pedestrians, cyclists and transit passengers.
- Does not account for many types of economic impacts, including vehicle ownership costs, parking costs, mobility options for non-drivers, physical fitness and health, and the economic development impacts of increased consumer expenditures on vehicles and fuel.

Consider a hypothetical example. A 300-student school located on a two-lane road experiences twice daily traffic congestion problems that cause 6-minutes average delays to 100 vehicles driven by parents chauffeuring children. When evaluating a proposal to expand the road to four lanes a conventional evaluation multiplies the 6-minute delays times 100 vehicles times two passengers times 400 annual trips to estimate that the project would save 8,000 annual hours in traveler time, worth $80,000 valued at $10 per hour, plus some fuel savings and emission reductions. These savings could justify up to $1.6 million for roadway expansion.

However, a wider road with faster vehicle traffic makes walking and cycling more difficult, which would cause 2 minutes of additional travel reach an intersection with a pedestrian signal, and 100 more parents to chauffeur their children, of whom 20 would purchase an additional car. The analysis should therefore include the additional pedestrian and cyclists travel times, additional time and vehicle operating costs for the 100 additional parents who drive, additional vehicle ownership costs to households forced to purchase more cars, and additional external costs – traffic congestion, parking subsidies, accident risk and pollution emissions – caused by the induced vehicle travel. The 100 additional vehicle trips would fill the added road capacity, causing congestion to return to previous levels so actual benefits would soon decline.

An alternative solution is to slow roadway traffic speeds, improve walking and cycling facilities, and encourage families to walk, bike, carpool and use transit. This would provide various benefits including vehicle and parking cost savings, improved parent and child fitness and health, and reduced noise and air pollution. However, conventional evaluation would not account for many of these benefits. Because it evaluates transport system performance based primarily on travel speeds, it considers shifts from driving to slower modes to reduce transport system performance, and overlooks many benefits from shifts to alternative modes (these shifts are only considered beneficial if they reduce motor vehicle congestion).

Table 8 summarizes the impacts of various evaluation biases on school transport planning decisions. These biases can have cumulative and synergistic (total impacts are greater than the sum of individual impacts) impacts with durable effects. For example, expanding a road to four lanes in anticipation of future traffic growth can help create a self-reinforcing cycle of more parents driving children to school, degraded walking and cycling conditions, and more automobile-oriented planning. Had the same resources been devoted to improving and encouraging alternative modes the need to expand the roadway could have been avoided.

Table 8 **Conventional Evaluation Bias Impacts**

Type of Evaluation Bias	Impacts on Planning Decisions
Mobility-based planning. Evaluates transport system performance based on vehicle travel speeds.	Favors higher roadway traffic speeds and roadway expansion. Undervalues non-motorized transport improvements.
Ignores consumer sovereignty. Fails to identify and serve latent demand for walking, cycling and public transit.	Underinvestment in alternative modes.
Exaggerated congestion costs and congestion reduction benefits.	Favors roadway expansion over other transport system improvement strategies.
Ignores vehicle ownership and parking costs.	Fails to support transport improvements that allow households to reduce their vehicle ownership and use.
Ignores public fitness and health impacts.	Favors motorized over non-motorized transport, and sprawl over walkable community planning.

Conventional transport evaluation is biased in various ways that tend to favor roadway expansion over other types of transportation improvements.

Evaluation distortions have similar impacts on other types of planning decisions. For example, many of the same biases also distort efforts to support economic development. Conventional evaluation implies that roadway expansion supports economic development by reducing producer transport costs, but the analysis fails to apply economic efficiency analysis, and ignores the impacts of generated and induced travel. As a result, conventional highway planning justifies highway expansions which provide little long-term benefits to businesses, and which induce more total vehicle travel and sprawl, increasing associated economic costs. More comprehensive evaluation recognizes the small productivity benefits and the potentially significant economic costs of roadway expansion, and so supports other types of transport system improvements such as improved intermodal freight facilities, more efficient road pricing and other transportation demand management strategies.

Implications of More Optimal Planning and Pricing

This analysis suggests that current transport planning fails to reflect some economic principles resulting in automobile dependent transport systems and economically excessive automobile travel. Table 9 summarizes these distortions, more optimal planning and pricing practices and the effects that these reforms would have on travel activity.

Table 9 **Evaluation Biases and Their Reforms** (Litman 2007 and 2012)

Principle	Current Conditions	Optimal Practices	Travel Impacts
Cost-based pricing	Road and parking use is often significantly underpriced. Only half of roadway costs and a smaller portion of parking costs are funded through user fees. Insurance and registration fees are mostly fixed, not related to the amount a vehicle is driven.	Roads are financed through user fees, with higher rates under congested conditions.	Automobile travel declines 5-10%, larger under urban-peak conditions
		Parking facilities are financed through user fees, unbundled and cashed out.	Reductions in vehicle ownership and use.
		Vehicle insurance and registration fees are distance-based.	Vehicle travel declines 5-15%
Comprehensive evaluation	Current planning considers a limited set of impacts and options	Decision-making account for all significant objectives, impacts and options. To the degree that automobile has significant overlooked impacts, or some options are overlooked, this could lead to more multi-modal planning.	Likely to shift transport improvement resources from roads and parking expansion to alternative modes and demand management solutions.
Consumer sovereignty	Conventional planning does not consider latent demand for walking and cycling, and higher-quality transit.	Planning process recognizes the benefits to consumers and society of accommodating latent demand for resource efficient modes.	Improved walking and cycling conditions, and some improvements in transit service.
Economic efficiency	Conventional planning does not incorporate economic efficiency	Road use is prioritized to favor higher value trips and more efficient modes with pricing or regulations.	Automobile travel is reduced, particularly under urban-peak conditions. Travel shifts to more efficient modes (ridesharing and public transit).
Integrated planning	Land use and transport decisions are often uncoordinated	More effort to integrate planning, such as improved walking conditions and reduced parking requirements in transit-oriented areas.	Possibly significant accessibility improvements that reduce automobile travel.
Accessibility-based planning	Accessibility- rather than mobility-based transport planning	Consideration of walking, cycling and public transit, roadway connectivity, and land use accessibility, and ways that roadway expansion can reduce other forms of accessibility in transport planning.	Possibly significant accessibility improvements that reduce automobile travel.

This table summarizes the travel impacts of more optimal transport planning.

For example, with more optimal planning and pricing, motorists would pay directly for using roads and parking facilities with higher prices under congested conditions, vehicle insurance would be distance-based, urban arterials would have bus lanes if there are more than about 20 buses per peak hour (since those lanes can carry more people than a general purpose lane), and non-motorized travel would receive priority and investment proportionate to its demand (including latent demand). More comprehensive planning, consumer sovereignty, economic efficiency, integrated planning and accessibility-based planning would tend to shift some resources from roadway expansion to improving alternative mode and implement demand management strategies. Applying standard elasticity values to these changes indicates that efficient pricing and neutral planning would result in consumers choosing to drive 30-50% less, rely more on alternative modes, significantly reduce their transport expenditures and external costs, and be better off overall as a result (Litman 2007). By increasing efficiency, reducing external costs imposed on governments and businesses, and leaving consumers with more money to spend on locally produced goods, which supports economic development.

This suggests that a significant portion of current motor vehicle travel is economically excessive, that is, it results from planning and pricing distortions that favor automobile travel over other modes and sprawl over more compact land use development, which consumers would willingly forego with more optimal planning and pricing. Evaluation practices ignore these factors will encourage further road and parking facility expansion that further exacerbates these inefficiencies.

For example, if an economic evaluation concludes that highway expansion will reduce traffic congestion and increase economic productivity, the analysis probably ignores the current degree that road use is underpriced and the external costs that induced travel will increase. Ignoring these impacts exaggerates the net economic benefits of highway expansion and undervalue alternative solutions such as improving alternative modes, more efficient pricing, or doing nothing so traffic congestion maintains equilibrium, since it will not get much worse if capacity is held constant and will actually be reduced little over the long run by expanding capacity. By more clearly communicating these points, economists may motivate people concerned about congestion problems to support efficient planning and pricing reforms – for example, economic development advocates, shippers and frustrated commuters should all support more efficient road, parking and fuel pricing as effective ways to reduce congestion delays.

Conclusions

Transportation planning decisions can have diverse impacts, including direct user impacts, indirect and external impacts, and economic development impacts that affect productivity, employment, property development and tax revenues. How these impacts are evaluated can significantly affect planning decisions: a policy or project that appears beneficial and fair evaluated one way may be considered inefficient and unfair if evaluated another.

This study indicates that conventional transport economic evaluation has significant omissions and biases. Its methods were originally developed to answer relatively simple questions such as whether a road project's costs would be repaid by vehicle travel time and operating cost savings. They are unsuited for evaluating multiple modes or demand management strategies.

Conventional evaluation fails to reflect basic economic principles including comprehensive evaluation, consumer sovereignty, economic efficiency, and planning integration. For example, it does not generally quantify the consumer welfare gains from serving latent demand for alternative modes, or the economic efficiency gains from favoring higher value trips and more efficient modes over lower value trips and less efficient modes. Alternative modes and demand management strategies are often valued only if they reduce vehicle traffic congestion.

Conventional evaluation measures *mobility* rather than *accessibility*, and so tends to undervalue improvements to alternative modes, increased transport network connectivity, and more accessible development. It exaggerates congestion costs, ignores ways that roadway expansion can reduce accessibility, and overlooks induced vehicle travel costs. Of four accessibility factors and ten economic impacts identified in this study, conventional evaluation only monetizes a few: government infrastructure costs, vehicle travel time and operating costs, and sometimes crash and emission rates. Other impacts are only considered qualitatively or ignored altogether.

Conventional evaluation inaccurately analyzes economic development impacts. It often treats economic transfers as efficiency gains, and inappropriately assigns productivity gains to personal travel time savings. It ignores the negative impacts that increased vehicle and fuel expenditures have on regional economic activity. Theoretical and empirical analyses indicate that high levels of motor vehicle travel can reduce economic development. This suggests that roadway expansions are often economically inefficient, particularly compared with policies that increase transport system efficiency, such as road space prioritization, more efficient road, parking and fuel pricing, and other transportation demand management strategies.

These biases and omissions tend to favor of mobility over accessibility and automobile travel over other modes. This results in reduced transport options, excessive roadway and parking supply, reduced roadway connectivity, sprawled development, and less demand management implementation economically optimal. This harms consumers directly and reduces economic efficiency. For example, ignoring the consumer sovereignty principle undervalues efforts to serve latent demands for resource efficient modes (walking, cycling and public transit), which reduces consumer welfare and increases external costs such as congestion, accident and pollution. Similarly, ignoring economic efficiency principles undervalues efforts to favor higher value trips and more efficient modes over lower value trips and less efficient modes. It is important that people who use evaluation results understand their omissions and biases.

Theoretical and empirical evidence indicates that current evaluation often recommend policies and projects that contradict their intentions: roadway expansion projects intended to reduce congestion delays, save money and support economic development actually increase total travel times and transport costs, and reduces productivity, as indicated in Table 10.

Table 10 **Conventional Evaluation Bias Impacts**

Objective	Theoretical	Empirical Evidence
Travel time savings – roadway expansions are predicted to save travel time.	Peak-period traffic speeds influence overall accessibility less than other factors such as modal options, roadway connectivity and land use accessibility.	Per capita travel times tend to be higher in automobile-oriented, sprawled communities with higher per capita roadway supply than in more compact and multi-modal communities.
Transportation cost savings - roadway expansions are predicted to reduce user and external costs	Vehicle operating cost savings that result from roadway expansion are small compared with other consumer costs that increase with automobile dependency and sprawl	Per capita transport costs, including both user and external costs, are higher in automobile dependent areas than in more multi-modal areas.
Economic development – roadway expansions are predicted to increase economic development	If motor vehicle travel is underpriced, roadway expansions often provide little long-term congestion reduction and induce additional vehicle travel increases many external costs.	Economic productivity is higher in compact, multi-modal urban areas and lower in urban areas that are more automobile-dependent and sprawled.

Roadway expansions often fail to achieve predicted benefits. They can increase costs and reduce economic efficiency by stimulating automobile dependency and sprawl.

This occurs because conventional evaluation generally ignores the tendency of roadway expansions to increase automobile dependency and sprawl, and therefore induce vehicle travel and associated costs. Conventional evaluation measures many impacts (travel speeds, vehicle operating costs, accidents and pollution emissions) per vehicle-mile and so ignores many of the incremental costs of induced vehicle travel (additional vehicle mileage that results from roadway expansions or reduced vehicle operating costs), and many of the benefits of demand management strategies that reduce total vehicle travel. These impacts should generally be measured per capita.

These are complex issues. This analysis does not suggest that all motor vehicle travel is economically inefficient, nor that roadway expansion is never justified. However, it does indicate that conventional evaluation results in economically excessive roadway capacity and vehicle travel which reduces economic productivity compared with what is most efficient and optimal.

To be fair, economic evaluation is just one part of the overall transport planning process. The overlooked factors are sometimes considered at other stages in a planning process, during public engagement or through special programs intended to achieve specific objectives, such as non-motorized transport planning or emission reductions. Many public officials support walking, cycling and public transport more than is justified by conventional economic evaluation – they realize intuitively that these modes have important roles to play in an efficient and equitable transport system not quantified in economic evaluation. However, this occurs *despite* rather than supported by the evaluation process. More comprehensive and multi-modal evaluation can result in more integrated and consistent planning.

This is a timely issue. During the twentieth century automobile travel grew steadily so it was rational to devote significant resources to expanding roadways and there was little risk of overbuilding, since any excess capacity would eventually be used. Early in the twenty-first century motor vehicle travel peaked in most developed countries (Litman 2006). Current demographic and economic trends (aging population, rising fuel prices, increasing urbanization, growing health and environmental concerns, changing consumer preferences) are increasing demand for alternative modes, and communities increasingly want planning which considers a wider range of objectives, impacts and options. Responding to these demands requires more comprehensive and multi-modal transport planning. Now, overbuilding roadway capacity will be as economically harmful as underbuilding, and transport planning will increasingly emphasize more efficient management of existing supply instead of system expansion. Transportation engineers tend to evaluate *efficiency* based simply on roadway and operating costs per vehicle-mile or –kilometer; economists can provide a more comprehensive definition which reflects principles of consumer welfare and economic efficiency.

Although previous studies have examined various problems with conventional transport economic evaluation, most focus on specific omissions and biases. This report applies a more comprehensive critique that bridges two different but overlapping disciplines: planners interested in comprehensive, accessibility-based evaluation that responds to changing community demands, and economists interested in economic principles such as consumer sovereignty and economic efficiency in order to maximize social welfare and support economic development, as indicated in Table 11. This study should be of interest to anybody involved in transport evaluation, or who uses evaluation results.

Table 11 **Planner and Economist Perspectives**

Planners	Both	Economists
• Expanding planning objectives in response to community concerns. • Accessibility-based transport system performance evaluation. • Demand management to achieve specific objectives such as congestion and pollution reductions.	• More comprehensive evaluation of impacts and options. • Understanding changing consumer demands. • Quantifying external costs.	• Consumer sovereignty (responding to latent demands). • Economic efficiency. • Efficient pricing. • Understanding economic development impacts.

Planners and economists have different concerns about transport evaluation distortions.

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