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Evaluating Rail Transit Criticism

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Abstract

This report evaluates criticism of rail transit systems. It examines claims that rail transit is ineffective at increasing public transit ridership and improving transportation system performance, that rail transit investments are not cost effective, and that transit is an outdated form of transportation. It finds that critics often misrepresent issues and use biased and inaccurate analysis. This is a companion to the report *Rail Transit in America: A Comprehensive Evaluation of Benefits*.

Contents

Executive Summary

Public transport (also called *transit*) can provide numerous benefits to users and society, as indicated in Table ES-1. Many of these benefits depend on the quality of service and the degree that transit can attract discretionary passengers who will otherwise drive, and therefore reduce automobile travel and associated costs such as traffic congestion, accidents and pollution emissions. This requires high quality rail or bus rapid transit (BRT) service that is relatively convenient, comfortable and fast (with grade separated tracks or lanes), plus attractive stations that provide a catalyst for transit-oriented development.

Table ES-1 **Public Transit Benefit Categories**

Mobility Benefits	Efficiency Benefits	Land Use Impacts
Benefits from increased mobility for non-drivers	Benefits from reduced automobile travel	Benefits from more compact, transit-oriented development
Improved user convenience and comfort Direct user benefits from improved mobility Increased education and employment opportunities Equity objectives (benefits disadvantaged groups) Option value (value non-users place on having services available for possible future use)	*Congestion reductions* *Roadway cost savings* *Parking facility cost savings* *Vehicle cost savings* *Reduced chauffeuring burdens* *Accident reductions* *Public fitness and health* *Energy conservation* *Emission reductions*	*Reduced land paved for roads and parking facilities; reduced stormwater management costs* *More compact development; reduced costs of providing public infrastructure and services, and openspace preservation* *Catalyst for urban redevelopment* *Increased local property values and tax revenues* *Agglomeration efficiencies*

Public transit can provide numerous benefits to users and society. Italics indicate the benefits that require high quality service to attract discretionary travelers who would otherwise drive.

Current demographic and economic trends (aging population, rising fuel prices, urbanization, increasing health and environmental concerns, changing consumer preferences, etc.) are increasing consumer demand for alternative modes. To prepare for these future demands and increase benefits many urban regions are investing in rail transit systems. Considering all impacts and benefits, such investments are often considered the most cost effective way to improve urban transport and support strategic planning objectives.

Transit project economic analysis can be confusing because different types of transit services provide different types of benefits. *Mobility benefits* require special equipment such as wheelchair lifts and service at times and places with low demand, which may seem inefficient due to high operating costs per passenger-mile. *Efficiency benefits* require premium service designed to attract discretionary travelers on major urban corridors which may seem inequitable due to relatively high costs and amenities that benefit wealthier users. As a result, some transit services may seem inefficient and others may seem inequitable, but each can be justified to achieve their objectives and benefits.

Rail transit investments are sometimes criticized as inefficient or inequitable. Some of this criticism is constructive, identifying possible ways to improve rail projects, but some criticism is inaccurate and unfair, based on incomplete analysis. This report evaluates these criticisms. Table ES-2 summarizes common criticisms and describes appropriate responses to inaccurate claims.

Table ES-2 **Common Criticisms and Responses**

Critics' Claims	The Truth	Appropriate Responses
Transit is outdated – demand is declining	Transit ridership declined in North American during the last half of the Twentieth Century, but is now growing. Current demographic and economic trends are increasing future transit demand.	Examine how current demographic and economic trends will increase future travel demands. Identify latent demand for high quality public transit. Show how transit supports strategic planning objectives.
Transit fails to attract new riders and reduce automobile travel	High quality transit usually significantly increases ridership, much of which substitutes for automobile travel. This indicates significant latent demand.	Examine ridership on high quality transit systems in similar communities. Survey travelers concerning the types of transit systems they want and would use.
Transit investments are not cost effective	Although rail transit may not be justified based on any single benefit, it is often cost effective considering all impacts.	Identify all major benefits. Emphasize that these benefits are widely distributed, including benefits to non-users.
Transit is ineffective at achieving objectives such as congestion and emission reductions	Critics often use incomplete or outdated analysis. Current research indicates that high quality transit can provide significant congestion and emission reductions.	Provide the best current information based on actual projects rather than average values. Evaluate integrated programs.
Transit is slow and inefficient	Rail and BRT are often time competitive with driving under urban-peak conditions. If high quality service is available travelers can choose transit when most efficient overall.	Identify how transit improvements can increase travel speeds and efficiency. Compare transit with automobile travel times under urban-peak conditions.
Transit is subsidized, automobile travel is not	Transit services are subsidized directly, automobile travel is subsidized indirectly by road and parking costs not borne directly by users, and fuel and pollution externalities.	Identify the full costs and subsidies of urban automobile travel. Compare subsidies per capita, not just per passenger-mile.
Rail transit harms poor people by reducing funding for basic transit services	Rail projects generally receive new transit funding. Basic bus service tends to increase as rail systems expand. Poor people do use and benefit from rail transit services.	Indicate how much of rail funding is "new." Highlight benefits to poor people from high quality transit services and more transit-oriented development.
Bus transit is cheaper than rail	Rail often has higher capital but lower operating costs than buses, and by attracting more riders has lower costs per passenger-mile and greater total benefits. True Bus Rapid Transit (BRT) incurs many of the same costs as rail for grade separation, high quality vehicles and attractive stations.	Compare long-run costs and benefits, including the additional benefits from high quality services that attract discretionary travelers.

Many common criticisms misrepresent key issues and can be challenged.

Critics often use incomplete comparisons between rail, bus and automobile transport. They understate total transit benefits and the full costs of increased urban automobile traffic. They claim that highway expansion is cheaper than urban rail but ignore important factors:

- Rail systems include vehicles, tracks and terminals. Automobile travel requires a vehicle, roadways and parking facilities at each destination. Rail system costs should therefore be compared with total roadways, vehicle and parking facility costs, not just roadways.
- Roadway, parking and vehicle operating costs tend to be relatively high on the urban corridors where rail systems are generally constructed. Rail transit costs should therefore be compared with these higher costs rather than average costs.
- Not everybody can, should, or wants to drive. High quality transit benefits non-drivers directly, and reduces motorists' chauffeuring burdens. Public transit improvements help achieve equity objectives by improving economic opportunity for disadvantaged groups and by providing non-drivers a fair share of transportation investments.
- Rail and BRT can help create more compact communities and reduce per capita vehicle travel, which helps achieve other planning objectives such as farmland and habitat preservation, urban community redevelopment, energy conservation and emission reductions. Highway expansion tends to contradict these objectives.

Similarly, critics also use incomplete analysis when they claim that rail transit is excessively subsidized.

- Urban rail generally has lower operating costs per passenger-mile and higher cost recovery than bus transit.
- Rail transit is often cheaper than accommodating additional automobile traffic on major urban corridors, considering total road, parking and vehicle costs.
- Although transit services require relatively large government subsidies, urban automobile travel requires comparable size indirect subsidies, including road and parking costs not borne by users, and external costs of fuel production, crash risks and pollution emissions.
- Motorists tend to drive more annual miles than transit users travel by transit, so even if transit subsidies are larger per passenger-mile, they tend to be much lower per capita.
- A major portion of transit subsidies are intended to provide basic mobility for non-drivers, including special equipment to accommodate people with disabilities, and services at times and places where demand is low. These costs should not be included when evaluating the transit service cost efficiency.

Rail transit investments can be an appropriate way to create more efficient and diverse urban transport systems that better respond to consumer demands and future economic conditions. Although few motorists want to give up driving completely, many would prefer to drive less and rely more on public transit, provided high quality service is available. Rail transit is not justified everywhere, but it is often a cost effective way to improve urban transport systems, considering all impacts and objectives.

Introduction

As people gain wealth they usually demand higher quality goods and services, and markets generally respond. More affluent consumers purchase better quality foods, nicer cars, and first-class air travel. But most communities only offer basic public transit services: slow and infrequent bus service, not-very-pleasant waiting conditions, and few user incentives and amenities. This assumes that people who rise from low- to middle-incomes will abandon public transit and shift to automobile travel.

There are good reasons to reconsider this approach. Not everybody can, should or wants to drive everywhere, and high quality public transit that attracts *discretionary travelers* (people who would otherwise travel by automobile, also called *choice riders*) provides direct benefits to users and various external benefits. High quality transit requires an integrated system that includes relatively fast, reliable and frequent service; comfortable and attractive vehicles and stations; transit-oriented development; good walking, cycling and feeder bus access; and various support policies such as convenient user information, integrated fares and efficient parking management. Residents of communities with high quality transit tend to own fewer vehicles, drive less, and rely more on alternative modes than they would in more automobile-dependent areas, providing various savings and benefits, as indicated in Table 1.

Table 1 **Public Transit Benefit Categories** (Litman 2008)

Mobility Benefits	**Efficiency Benefits**	**Land Use Impacts**
Benefits from increased mobility for non-drivers	Benefits from reduced automobile travel	Benefits from more compact, transit-oriented development
Improved user convenience and comfort Direct user benefits from improved mobility Increased education and employment opportunities Equity objectives (benefits disadvantaged groups) Option value (value non-users place on having services available for possible future use)	*Congestion reductions* *Roadway cost savings* *Parking facility cost savings* *Vehicle cost savings* *Reduced chauffeuring burdens* *Accident reductions* *Public fitness and health* *Energy conservation* *Emission reductions*	*Reduced land paved for roads and parking facilities; reduced stormwater management costs* *More compact development; reduced costs of providing public infrastructure and services, and openspace preservation* *Catalyst for urban redevelopment* *Increased local property values and tax revenues* *Agglomeration efficiencies*

Public transit can provide numerous benefits to users and society. Italics indicate the benefits that require high quality service to attract discretionary travelers who would otherwise drive.

Many urban regions are building or expanding rail or bus rapid transit (BRT) systems to attract more discretionary travelers and achieve these benefits. In most communities this requires changing transportation planning and investment practices. The Twentieth Century was the period of automobile ascendency, during which automobile travel grew from almost nothing into a dominant mode. During this period it made sense to invest significant resources in roads and parking facilities. The automobile transport system is now mature: it is possible to drive from most origins to most destinations with relative convenience, comfort and safety. The major transport problems facing most communities are traffic and parking congestion, inadequate mobility for non-drivers, high user costs of owning and operating vehicles, and various external costs such as accident risks and pollution emissions; all problems that can be reduced by improving alternative modes. This can justify major investments in high quality public transit.

Some people criticize these investments as excessive and wasteful, referring to the "hundreds of billions of dollars" spent on public transit during the last few decades. However, transit actually receives a small portion of total transport spending. The U.S. currently spends about $55 billion annually in total on public transit, about $180 per capita, which is only about 2% of the estimated $8,000 spent per capita on vehicles, fuel, roads and parking facilities, not counting additional external costs such as uncompensated crash and pollution damages, and fuel production externalities.

Current demographic and economic trends (aging population, rising fuel prices, increasing urbanization, increasing health and environmental concerns, and changing consumer preferences) are increasing future demands for high quality public transit. Although few motorists are expected to give up driving altogether, surveys indicate that many would prefer to drive less and rely more on alternative modes, provided they are convenient and comfortable.

Meeting these demands requires a paradigm shift, a change in the way problems are defined and solutions evaluated. The old paradigm generally assumed that transit investments should be evaluated based on *cost minimization*, the lowest cost per vehicle- or passenger-mile, resulting in lower quality service. The new paradigm evaluates investments based on *service quality maximization*, which justifies higher initial investments if they result in higher quality services that attract more travelers and therefore provides more total benefits. This requires determining whether incremental costs are offset by total incremental benefits to users and society.

Such analysis can be difficult because different modes have different cost and benefit profiles. Automobile transport has high fixed and external costs, particularly under urban travel conditions, and relatively small variable costs. Bus transit has relatively low capital costs but higher operating costs. Rail transit has high capital costs, but on major urban corridors has relatively low operating costs per passenger-mile. Economic evaluation can therefore be affected by how costs and benefits are defined and measured, such as whether analysis considers automobile ownership in addition to operating costs, and whether it uses average costs, or the higher costs of urban conditions.

This report investigates these issues. It investigates how much higher quality transit increases ridership and reduces automobile travel, discusses impacts and benefits, evaluates various rail transit criticisms, and examines specific examples of such criticism. It describes best practices to apply when comparing different transport modes. Although this report focuses on rail transit, many conclusions apply to other forms of public transit such as bus rapid transit (BRT), in which incremental costs for higher quality services must be compared with incremental benefits.

Rail Transit Transport Impacts

A key factor in this analysis is the degree that rail transit attracts new users and reduces automobile travel. This chapter summarizes information on these subjects. For more information see Arrington, et al. (2010), Boarnet and Houston (2013), CTS (2009), Lane (2008), Kenworthy (2008), Litman (2004a and 2008) and Xie (2012).

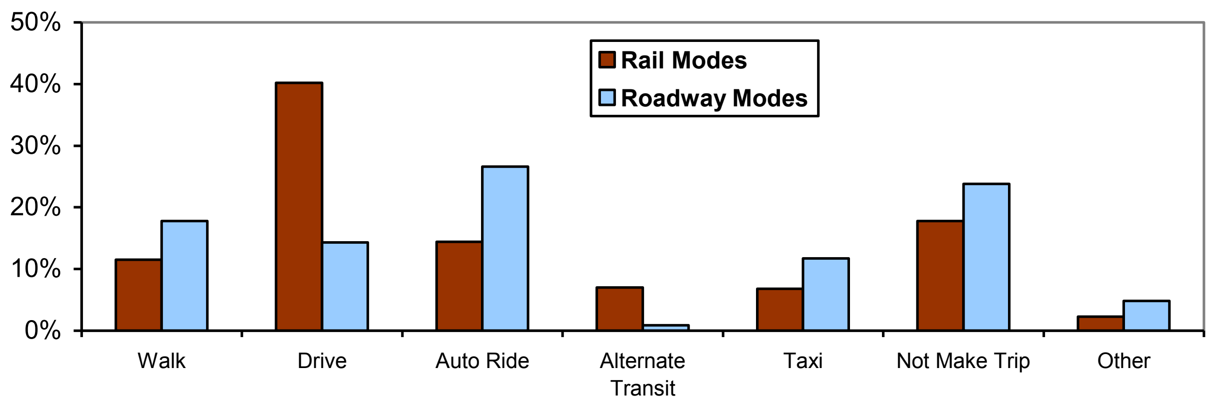
Table 1 **Demand Characteristics By Transit Mode** (CTS 2009)

Service Type	Definition	Type of Rider	How Accessed	Trip Characteristics
Light-Rail Transit	Hiawatha Line from downtown Minneapolis to southern suburbs	Mostly (62%) choice	Balanced between bus, walking, and park and ride	Home locations spread throughout the region; the average rider lives more than three miles from the line.
Express Bus	Connects suburban areas to downtowns	Primarily choice (84%)	About half park-and-ride (48%)	Home locations clustered at the line origin
Express Bus	Express routes with coach buses	Almost exclusively choice (96%)	Mostly park and ride (62%)	Home locations clustered at the line origin
Local Bus	Serves urban and suburban areas with frequent stops	Mostly captive (52%)	Nearly all bus or walk (90%)	Home locations scattered along route; most riders live within a mile of the bus line

Rail transit tends to attract more "choice" riders (discretionary transit users who could drive).

Because rail usually provides relatively high service quality (speed, comfort and integration) and helps create transit-oriented development, it tends to have high automobile substitution rates and leverages large vehicle travel reductions, as indicated in Table 1 and Figure 1. People who live or work in areas with high quality rail transit tend to own fewer automobiles, drive less, and rely more on alternative modes than in more automobile-oriented areas (Evans and Pratt 2007; Henry and Litman 2006; Lane 2008; CTS 2009). These vehicle travel reductions result from a combination of shifts to walking, cycling and public transit, and shorter vehicle trips due to more compact development. Conventional bus transit tends to have smaller impacts and benefits.

Figure 1 **Alternative Travel Option** (APTA 2007, Table 20)



If transit were unavailable, more than half of rail passengers would travel by automobile.

Because transit riders tend to travel on congested urban corridors, they tend to have much larger congestion reduction impacts than their regional mode share. For example, although only 11% of Los Angeles commutes use transit, when a strike halted transit service for five weeks, average highway congestion delay increased 47%, and regional congestion costs increased 11% to 38% (Anderson 2013), with particularly large speed reductions on rail transit corridors (Lo and Hall 2006), indicating that higher quality, grade-separated service is particularly effective at reducing congestion.

Similarly, research by Laval, Cassidy and Herrera (2004) indicates that a disruption of the Bay Area Rapid Transit (BART) system would cause severe traffic problems on area roads. Without BART service, Bay Bridge congestion would create morning backups stretching 26 miles with 9 miles per hour speeds, and afternoon backups stretching 31 miles with 11 miles per hour speeds. “We found that the peak morning rush hour will go from two hours starting at 7 a.m. to a staggering seven hours, so half the workday would be gone by the time drivers step out of their cars,” said coauthor Michael Cassidy.

Analyzing travel activity in U.S. cities, Bento, et al. (2003) found that “rail supply has the largest effect on driving of all our sprawl and transit variables.” They concluded that a 10% increase in rail service reduces driving 4.2% or 40 annual vehicle miles per capita (70 VMT including New York City), compared with just a one mile reduced by a 10% bus service increase. Baum-Snow and Kahn (2005) and Renne (2005) found that between 1970 and 2000 transit mode shares declined much less in cities with rail transit than those that rely only on bus transit, and that transit ridership rates are much higher in areas near rail transit lines than in otherwise similar areas.

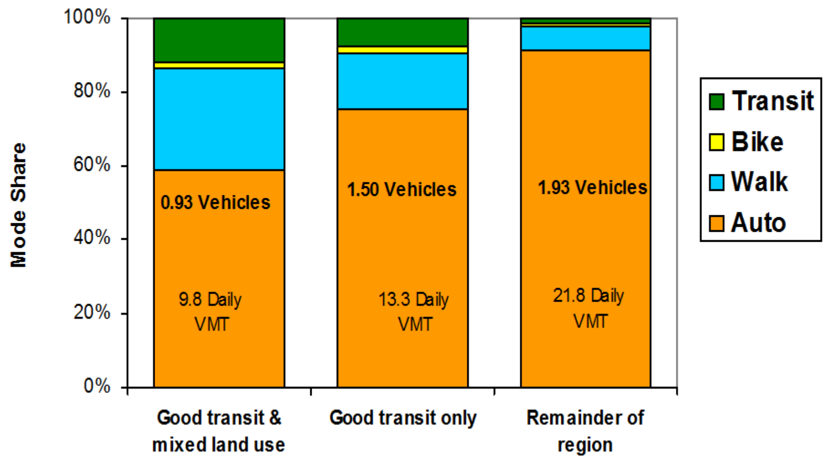
Aftabuzzaman, Currie and Sarvi (2010 and 2011) also analyze the role that public transit can play in reducing roadway traffic congestion. Using factor analysis they identify and quantify three ways that high quality public transit reduces traffic congestion: (1) transit-oriented factor, (2) car-deterrence factor, and (3) urban-form factor. Regression analysis indicates that the car-deterrence factor makes the greatest contribution to reducing traffic congestion, followed by transit-oriented factor and urban-form factor. They conclude that high quality public transit provides $0.044 to $1.51 worth of congestion cost reduction (Aus$2008) per marginal transit-vehicle km of travel, with an average of 45¢, with higher values for circumstances with greater degrees of traffic congestion, and if both travel time and vehicle operating costs are considered.

Ewing, Tian and Spain (2014) investigated the effects that Salt Lake City's University TRAX light-rail system has on vehicle traffic on parallel roadways. This rail system began operating in 2001 and expanded over the following decades with new lines and stations. It currently carries about 53,000 average daily passengers. The study found significant declines in roadway traffic after the LRT line was completed, despite significant development in the area. The study estimates that the LRT line reduced daily vehicle traffic on the study corridor about 50%, from 44,000 (if the line did not exist) to 22,300 (what currently actually occurs).

A study of California Transit-Oriented Developments (TODs) found that transit station area residents commute by transit five times more than average in their city, with transit mode shares averaging 27% within ½ mile of rail transit stations (Lund, Cervero and Willson 2004). Gard (2007) found that TOD typically increases transit ridership 2-5 times and reduces vehicle trips 8% to 32% compared with conventional land use development. Arrington, et al. (2008), found that Transit-Oriented Developments generate about half the vehicle trips as conventional, automobile-oriented development. Xie (2012) that new subway lines in Beijing increased residents' subway travel 98.3% and their walking and cycling travel 11.8%, and decreased their auto travel 19.8%, compared with areas that did not get subways.

Figure 2 shows how location factors affect vehicle ownership, daily mileage and mode split. Transit-oriented neighborhoods, with good transit and mixed land use, have far lower vehicle ownership and use, and more walking, cycling and public transit use than other areas. Residents of areas with high quality transit drive 23% less, and residents of areas with high quality public transit *and* mixed land use drive 43% less than elsewhere in the region, indicating that land use and transportation factors have about the equal impacts on travel activity.

Figure 2 **TOD Impacts On Vehicle Ownership and Use** (Ohland and Poticha 2006)



Transit-oriented development residents tend to own fewer vehicles, drive less and use alternative modes more than in automobile-oriented communities. "Daily VMT" indicates average daily vehicle miles traveled per capita.

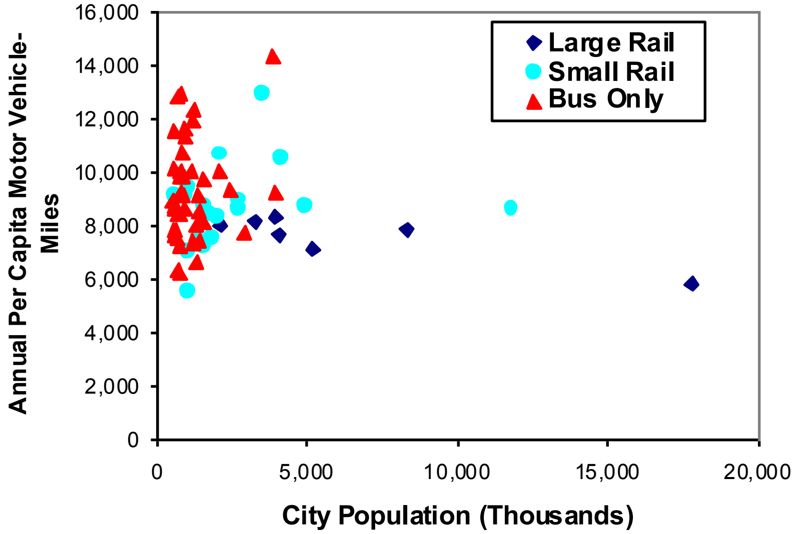
Table 2 **Transit VMT Reduction Impacts** (Holtzclaw 2000; ICF 2008 & 2010; Litman 2004a)

Study	Cities	Vehicle-Mile Reduction Per Transit Passenger-Mile	
		Older Systems	Newer Systems
Pushkarev-Zupan	NY, Chicago, Phil, SF, Boston, Cleveland	4	
Newman-Kenworthy	Boston, Chicago, NY, SF, DC	2.9	
Newman-Kenworthy	23 US, Canadian, Australian and European cities	3.6	
Holtzclaw 1991	San Francisco and Walnut Creek	8	4
Holtzclaw 1994	San Francisco and Walnut Creek	9	1.4
Litman 2004a	50 largest U.S. cities.	4.4	
ICF 2008	U.S. cities	3-4	

Several studies indicating that high quality transit can leverage additional vehicle travel reductions.

As a result, rail transit systems typically leverage a reduction of 2-9 vehicle miles traveled (VMT) for each rail passenger-mile, as indicated in Table 2. This results in significantly lower regional vehicle travel, not just in transit-oriented neighborhoods. On average, residents of regions with high quality rail transit systems typically drive about 20% fewer vehicle miles (VMT) than in comparable regions that lack such service (Litman 2004a; Kenworthy 2008)., as indicated in Figure 3.

Figure 3 **Average Per Capita Annual Vehicle Mileage** (FHWA 2002, Table 71)



Residents of urban regions with large rail transit system tend to drive significantly less than residents of other cities.

At the local level, some of these effects reflect *self-selection*, the tendency of people to choose neighborhoods that reflect their transport abilities and preferences (Cervero 2007). For example, non-drivers tend to choose transit-oriented neighborhoods. However, there is plenty of evidence that people do reduce vehicle ownership and mileage after moving to transit oriented areas (Cervero and Arrington 2008). That overall average VMT is lower in transit-oriented regions, including areas not serviced by rail, indicates that rail has broad travel impacts.

Common Criticisms

This section investigates various arguments often raised by critics.

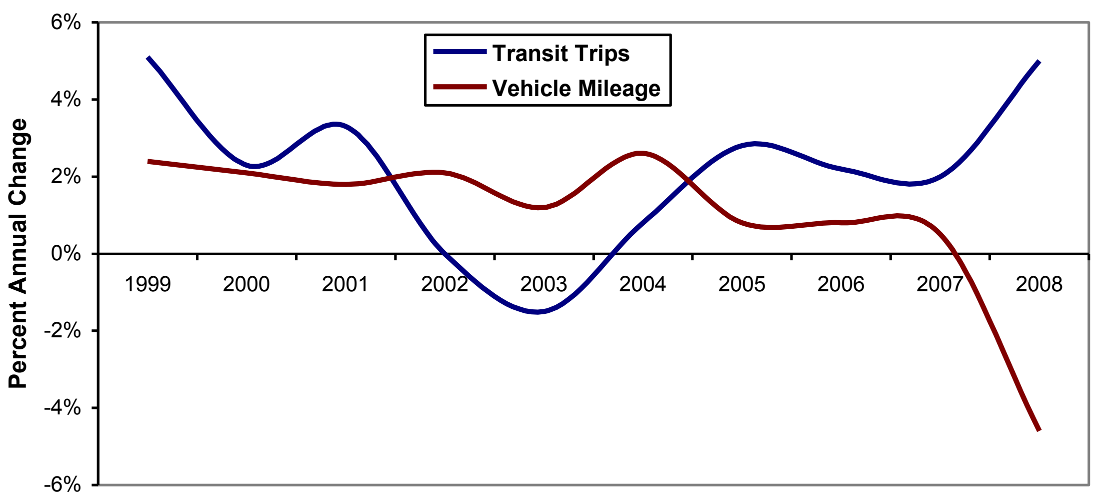
Rail Transit Is Outdated – Demand Is Declining

Critics (Cox 2010; Keane 2006; O'Toole 2004 and 2005) extrapolate past trends to argue that rail is an outdated mode of transport with declining demand. These claims are themselves outdated. It is true that during the Twentieth Century automobile (including cars, light trucks, vans and SUVs) ownership and travel grew, land use development sprawled, and transit investments, service quality and ridership declined. However, these trends are now reversing, resulting in growing demand for high quality transit (Litman 2005a; Reconnecting America 2004):

- Aging population, rising fuel prices, increased urbanization and changing consumer preferences are increasing demand for alternative modes and multi-modal development.
- Road and parking facility expansion costs are increasing while marginal economic benefits are declining, since the most beneficial highway projects have already been built.
- Many cities are growing to a size and density that justifies more reliance on transit, including many suburbs that are becoming cities and so need urban transport systems.
- There is growing support for more integrated transport and land use planning by professional organizations such as the Institute of Transportation Engineers (ITE 2003).

Between 1995 and 2009 the U.S. population grew 15%, VMT 21%, and transit ridership 31% (Figure 4). This and other travel data indicate that automobile travel growth rates are declining while demand for transit is growing.

Figure 4 **Highway and Transit Travel Trends** (BTS 2003, Table 1-34)

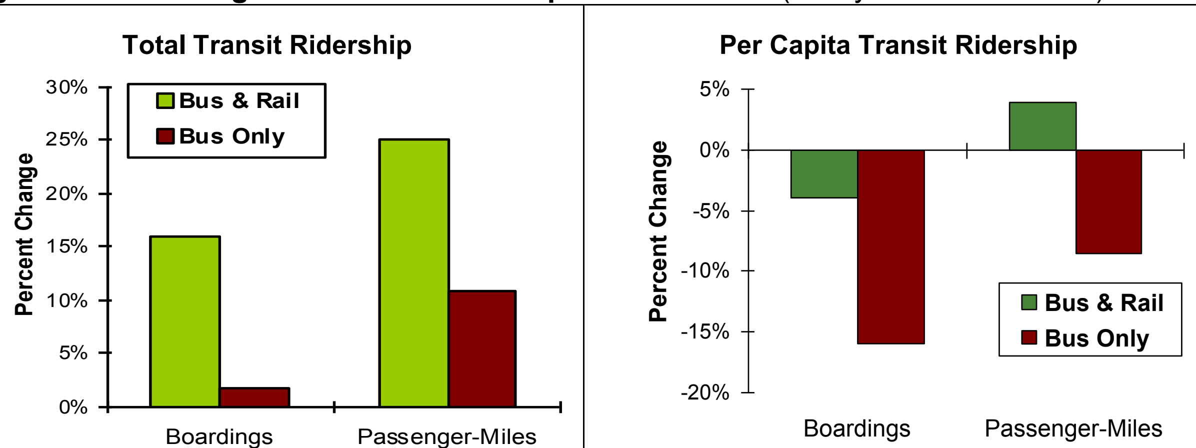


Between 1995 and 2009 transit ridership grew much faster than population or vehicle travel.

Rail Fails to Attract New Riders And Reduce Automobile Travel
Critics claim that Americans will not use transit, making transit investments futile (Cox 2010; Keane 2006). This is untrue. Although transit generally carries only a small portion of total regional travel, where high quality transit service is available (called *transit competitive* corridors) it often carries a significant portion of travel (Ehrenhalt 2009). Cities with high quality rail typically have 20-50% transit commute mode shares, and even higher rates to major commercial centers (Evans and Pratt 2007). As previously described, many cities experience significant transit ridership growth after building or improving rail transit systems, indicating latent demand for such service, that is, many more people would use transit if available (Demery and Setty 2005; Lane 2008).

Critics point out that transit ridership declined even in rail transit cities (Keane 2006), but such declines were smaller than in cities without rail (Baum-Snow and Kahn 2005; Renne 2005). For example, Freemark (2014) found that, of five cities that established rail transit systems during the 1980s, only one (San Jose) experienced transit mode share growth between 1980 and 2012, but their transit mode shares declined far less than 61 otherwise similar metro areas whose median transit mode share declined from 3.6% to just 1.7%. Schumann (2005) found that transit ridership grew significantly in Sacramento (CA) after it built a rail transit system, but declined in Columbus (OH), which only has bus transit. Transit operating costs increased faster in Columbus than in Sacramento, and voters approved more transit funding in Sacramento than Columbus. Henry and Litman (2006) found that U.S. urban areas that expanded rail systems between 1996 and 2003 had significantly more ridership growth than those that only expanded bus systems (Figure 5).

Figure 5 **Changes in Transit Ridership – 1996 to 2003** (Henry and Litman 2006)



Total transit use increased much faster in cities that have new or expanded rail service than in cities that only expanded bus service.

Per capita transit use declined less or increased in cities that expanded rail service compared with cities that only expanded bus service.

As previously described, Rail tends to have particularly high automobile substitution rates and new transit oriented developments tend to cause significant reductions in residents vehicle travel compared with conventional development.

Valley Metro Train On Washington Avenue In Phoenix, Where Ridership Exceeds Expectations
By Jennifer Steinhauer, *New York Times*, 19 September 2009

PHOENIX — Among the many detractors — and they were multitudinous — who thought a light rail line in this sprawling city would be a riderless $1 billion failure was Starlee Rhoades, spokeswoman for the conservative Goldwater Institute, a vocal critic of the rail's expense. "I've taken it," Ms. Rhoades said, slightly sheepishly. "It's useful." She and her colleagues still think the rail is oversubsidized, but in terms of predictions of failure, she said, "We don't dwell."

The light rail here, which opened in December, has been a greater success than its proponents expected, but not quite the way they envisioned. The rail was projected to attract 26,000 riders per day, but the number is closer to 33,000, boosted in large part by weekend riders. Unlike the rest of the country's public transportation systems, which are used principally by commuters, the 20 miles of light rail here stretching from central Phoenix to Mesa and Tempe is used largely by people going to restaurants, bars, ball games and cultural events downtown. Only 27% use the train for work, according to its operator, compared with 60% of other public transit users on average nationwide.

The hooting of an oncoming sleek new train is a sound many in Phoenix are still becoming used to, but it has given the city a distinctly modern feel. In some part thanks to the new system, downtown Phoenix appears to be one of the few bright spots in an otherwise economically pummeled city. "There has been this pent-up demand for downtown Phoenix to grow up," said real estate agent Nick Bastian, "And the light rail has given people an excuse to say let's go down there and check it out."

"It is bringing us new customers who didn't have time to get in the car and drive out here before," said Joel Miller, a co-owner of Maizies Cafe and Bistro, which sits right along the rail line. The gaggle of light rail users — including Arizona State University students — have given a small part of the city a new, dense connectivity that was more or less unheard of in the city two years ago. Pub crawls along the light rail have become a weekend staple, and restaurants have seen new customers.

"I think the biggest impact of the light rail is less tangible," said Matt Poolin, owner of Matt's Big Breakfast, a busy spot along the line, "which is that it really improves the image and perception of Phoenix's downtown, which, although experiencing a significant renaissance in recent years, still is undergoing many improvements and changes. The light rail, largely because it is so well run and nicely appointed, is something that I think most people are really proud of and feel positive about. It is rare to hear anyone complain, despite all of the controversy."

The controversy was largely attached to the rail line's cost — $1.4 billion — and the relatively low ticket price — $1.75 each way, with all-day passes for $3.50 and discounted rates for longer-term passes. In a city with low density, miles of suburban sprawl to the east and west of downtown and a historical lack of passion for public transportation, the rail line seemed like a white elephant. But its development over the last decade coincided with the city's expansion of the downtown convention center, the rise of the new A.S.U. campus and the booming commercial and residential real estate market that helped fuel growth of Phoenix. Since 2001, when the tax for the new rail line was approved, there has been about $5 billion in mostly private investment around the light rail line.

Valley Metro, the line's operator, hopes to add 37 miles toward Glendale and northeast Phoenix, breaking ground in 2012 and completing the extensions by 2017.

Pickrell (1992) and Flyvbjerg (2002) use historical data (mostly prior to 1980) to argue that rail projects often fail to achieve projected ridership, but such errors have declined significantly due to improved modeling (FTA 2007 and CTOD 2009). Most recent rail projects meet or exceed their ridership projections (Henry and Dobbs 2013). Table 3 summarizes some recent projects.

Table 3 **Light Rail Projects Completed Within Budget and Schedule** (LRN 2001)

City & Year	Actual Completion and Ridership Compared With Projections
Calgary (1987)	Northwest line extension, opened in 1987, completed months ahead of schedule and $3M under budget at a cost of (1987 Canadian) $104M. [Source: *TRB Special Report 221* (1989)]
Dallas (2001)	North Central and Northeast LRT extensions are on schedule and under budget. The total budget was reduced by $17 million due to excellent bid prices. [Source: DART Oct. 2000] Ridership averages about 40,000 passengers a day, 10% higher than forecast. [Source: DART 2000]
Denver (2000)	The nearly 9-mile-long Southwest light rail line to Littleton, which opened July 2000, came in on target at a total cost of $178 million. Ridership averaged about 14,000 weekday passengers, 67% above original projections. [Source: Denver RTD; *Denver Business Journal* 26 Jan. 2001]
Edmonton (1978)	This project was completed on time and within its budget of (1978 Canadian) $65m. [Source: *TRB Special Report 182* (1978)]
Houston (2004)	Houston's METRORail system was completed on time, within budget, and ridership has grown steadily since the system began operation. [Source: Houston Metro]
Memphis (2004)	The original budget for construction and procurement of five heritage streetcars was $75m, actual costs were approximately $55M. [Source: MATA website]
Minneapolis (2005)	The Hiawatha/Central LRT weekday ridership was projected to be 19,300 in 2005 and 24,600 in 2020, but reached 25,000 in August 2005. [Source: MetroTransit (www.metrotransit.org)].
Portland (1986, 1998)	Eastside (1986, $214 m) and Westside (1998, $964 m) projects were completed within the FTA funding agreement budget [Center for Transportation Excellence]. Westside first year ridership exceeded forecasts 22% [Tri-Met, 2000] and in 2005 exceeded 2008 ridership targets [Tri-Met, 2005].
Sacramento (1998, 2003)	Mather Field Road extension (2.5 mi), plus doubletracking from Starfire to Butterfield and the Brighton Bridge were completed on time and for $37m, about 10% under the $40 million projection [Source: LTK Engineering (2000)]. 2003 extension was completed on time and within budget.
Salt Lake City (1999)	According to Utah Transit Authority Grants Administrator's Office, the publicly budgeted amount for the TRAX LRT system was $312m when funded. Actual payout was only $300m. By 2001, ridership averaged 20,000 weekday passengers, exceeding forecasts by 43% [Source: Utah Transit Authority, 2000; *Denver Business Journal* 26 Jan. 2001].
San Diego (1981)	The first Trolley line was completed on time and within the budget of $86.5M (1981). [Source: APTA, North American Rail Transit (1991); J Schumann, LRT cost table (1996)]
St. Louis (1993, 2001)	The first MetroLink was completed on time and on budget for $355 m. The second line opened ahead of schedule and under budget. First year ridership exceeded 20,000 daily passengers, 67% higher than projected. 2001 ridership reached 40,000 daily passengers, exceeding the 20-year projection of 37,000. [Source: Bi-State Dev. Agency, 2000; Citizens for Modern Transit, 2001]
Tacoma (2004)	The $80m Tacoma Link project, which included various urban enhancements in addition to the rail line, came in under budget and ahead of schedule. [*Seattle Post-Intelligencer*, 23 Aug. 2003; *Tacoma News Tribune*, 22 Aug. 2003] Ridership, already exceeding 2010 projections. [Source: Sound Transit]

This table summarizes recent rail transit projects completed within budget and schedule.

Rail Is Not Cost Effective
Critics argue that rail transit projects are not cost effective for achieving specific objectives such as congestion reduction, energy conservation, pollution reductions, or improving accessibility for non-drivers (O'Toole 2006; Cox 2010; Castelazo and Garrett 2004; Winston and Maheshri 2006). This may be true if such objectives are considered individually but not if considered together. The value of a transit project is the sum of its *total* benefits minus total costs. Critics generally ignore many economic impact categories, as indicated in Table 4, and ignore indirect benefits from overall reductions in per capita vehicle ownership and use. For example, they generally ignore parking cost savings, vehicle ownership savings, accident reductions, energy savings and pollution reductions that result if high quality transit allows households to own fewer vehicles and reduce mileage. As a result, they significantly undervalue total transit benefits.

Table 4 **Scope of Analysis** (Litman 2008)

Impacts Considered by Rail Critics	Impacts Considered by Rail Advocates
Government costs Direct congestion reductions Vehicle operating costs Direct energy conservation Direct emission reductions	Government costs Direct and indirect congestion impacts Road and parking cost savings Vehicle ownership and operating costs Per capita accident reductions Improved accessibility for non-drivers Per capita energy consumption and pollution emissions Land use development impacts Public fitness and health

Rail critics tend to consider fewer benefit categories than advocates.

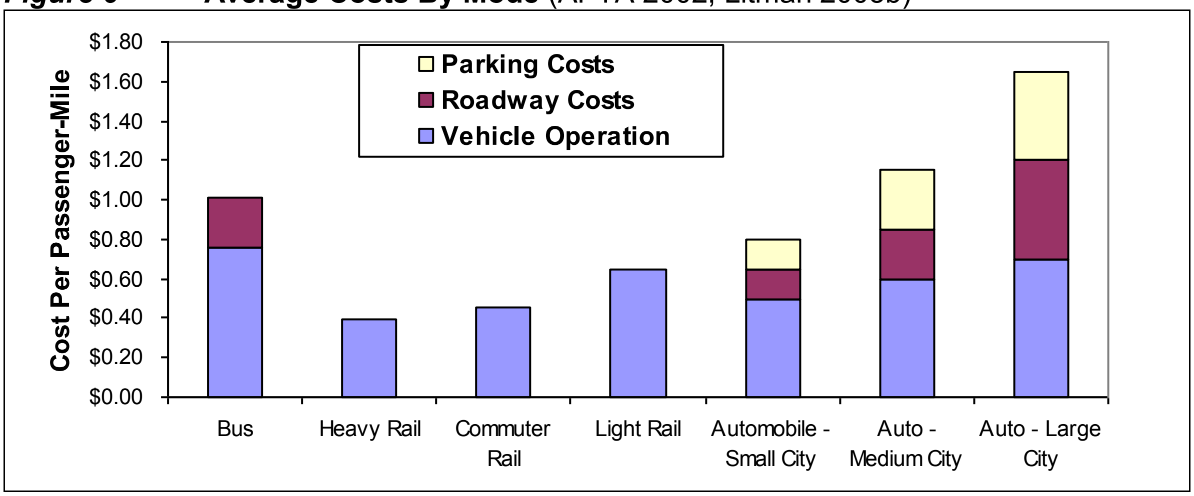
Public transit economic evaluation is complicated because transit service has two very different and often conflicting objectives: *equity* (basic mobility for non-drivers, which requires service at times and locations with low demand, and special equipment such as wheelchair lifts); and *efficiency* (reduced congestion, road and parking costs, accidents and pollution, which requires high-quality service concentrated on major corridors). As a result, equity-oriented transit service may seem inefficient (high costs per passenger-mile), while efficiency-oriented transit service may seem inequitable (they favor wealthy people), but this reflects their different objectives (Walker 2008).

Rail transit projects have large initial capital costs and take many years to build ridership, so short-run cost often seem high and benefits small, but costs decline and benefits increase as ridership grows. As a result, rail transit tends to be justified when evaluated using a long-term perspective that accounts for factors such as increasing aging population, rising future fuel prices, urbanization, growing health and environmental concerns, and more smart growth land use policies.

Critics often exaggerate the incremental costs of providing high quality transit. Low quality transit (infrequent bus service in mixed traffic) intended to provide basic mobility for non-drivers typically costs about $50-100 annually per capita, of which 10-20% can be recovered by fares. High quality transit (frequent, grade separated bus and rail service, with nice stations and support strategies such as transit oriented development), typically costs $200-500 annually per capita, of which 20-50% is recovered from fares, requiring $100-300 in additional annual subsidy. These extra costs and subsidies are often cost effective due to the greater total benefits provided by high quality transit.

Critics also tend to underestimate the full costs of accommodating automobile travel on the same corridors. Automobile travel requires roadways, parking facilities and vehicles (Figure 6), so it is inappropriate to compare transit project with just roadway expansion costs; the analysis should also consider vehicle and parking costs. Critics sometimes quote *average roadway construction* costs, ignoring other costs such as land acquisition and intersection construction, which tend to be much higher than average on major urban corridors where rail systems are developed. They generally overlook generated traffic impacts (additional vehicle traffic induced by roadway expansions), and therefore exaggerate congestion reduction benefits, and underestimate incremental external costs such as additional downstream congestion, accidents and pollution (Gorham 2009).

Figure 6 **Average Costs By Mode** (APTA 2002; Litman 2003b)

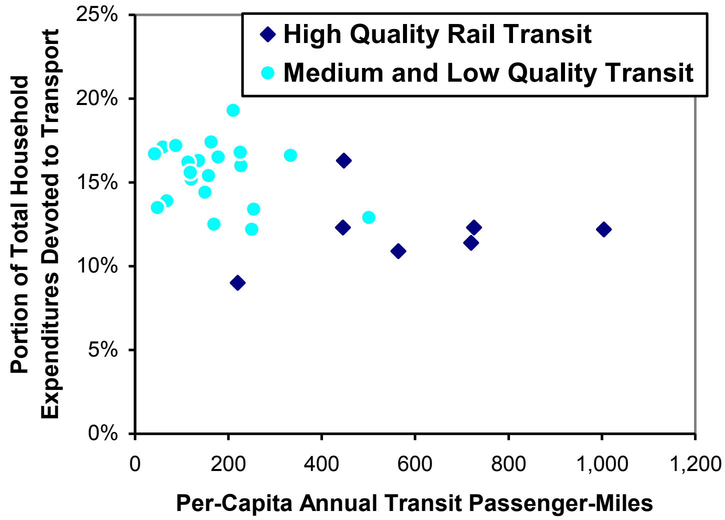


Rail transit often costs less overall than accommodating additional urban peak vehicle travel.

Critics argue that public transit cost efficiency (cost or subsidy per passenger-mile) has declined (O'Toole 2009), but this partly reflects efforts to provide basic mobility in sprawled areas. Transit cost efficiency is higher for rail than bus service due to operational efficiencies (more passengers per car, faster passenger loading, grade separation) and higher load factors (Litman 2004a), and can be improved further with supportive policies such as more transit-oriented development.

For average households, rail transit investments can be quite cost effective (Litman 2010). High quality rail transit typically costs about $300 in additional subsidies and $100 in additional fares annually per capita compared with basic transit service, but provides vehicle cost savings averaging about $500 annually per capita, plus road and parking cost savings of similar magnitude, plus various other savings and benefits including reduced congestion, accidents and pollution emissions, improved mobility for non-drivers, and improved fitness and health (Litman 2004a). The portion of household expenditures devoted to transport declines with increased per capita transit travel, and is particularly low in cities with high quality rail transit systems (Figure 7). This indicates that residents should rationally support tax increases if needed to create high quality public transit systems in their communities.

Figure 7 **Percent Transport Expenditures** (Litman 2004a)



The portion of total household budgets spent on transportation (automobiles and transit) tends to decline with increased transit ridership and tends to be lower in cities with high quality transit. Residents should rationally support tax increases needed to create high quality rail transit systems in their communities.

Improving transit service quality can provide various consumer savings and benefits:

- Higher quality service gives travelers a convenient and comfortable option when they cannot or prefer not to drive.
- Travelers shift from driving to public transit, reducing variable costs (fuel, vehicle wear-and-tear, parking fees, tolls and citations).
- Households can reduce their vehicle ownership, saving vehicle purchase, financing, depreciation, insurance and registration fees, and residential parking requirements.
- More accessible, compact and mixed development reduces driving distances, and allows more trips to be made by walking and cycling.
- Improving transportation options reduces the need to chauffeur non-drivers.

Several studies indicate that rail transit services provide net benefits to society even though most of these consider only a few categories of benefits. For example, Parry and Small (2007) conclude that fare subsidies of 50% are welfare improving (provide net benefits to society), considering congestion, pollution, and accident reductions, and scale economies in transit supply. Similarly, Nelson, et al (2006) found that bus and rail transit provides direct user and congestion reduction benefits that significantly exceed transit subsidies. These studies overlooked additional benefits, such as parking and vehicle ownership cost savings, and indirect benefits from more compact, accessible land use development, and so understates total transit benefits.

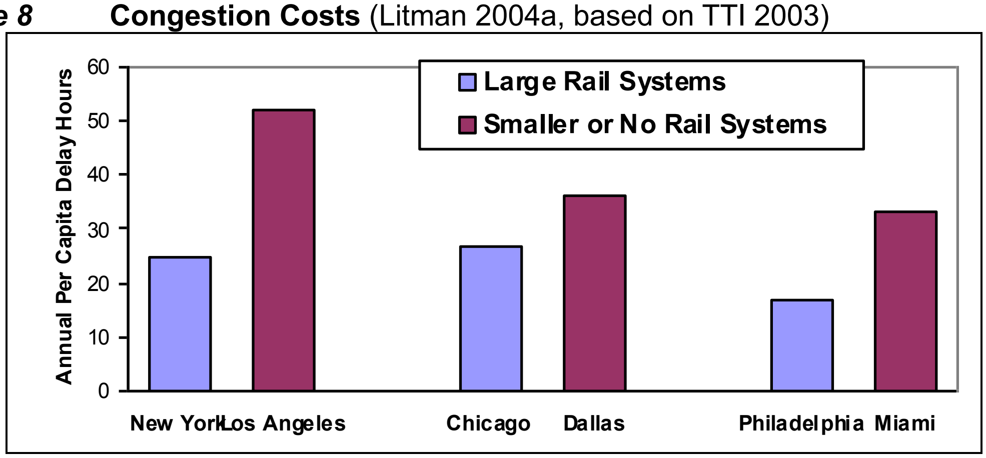
Rail transit's ability to achieve specific benefits is discussed below.

Traffic Congestion

Critics claim that rail transit fails to reduce traffic congestion (Cox and O'Toole 2004; Rubin and Fatma Mansour 2013). Such claims are wrong, generally based on inaccurate analysis (Litman 2014). Traffic congestion and rail transit both tend to increase with city size and density, but this does not means that rail transit *causes* congestion. On the contrary, studies that take into account these factors indicate that high quality transit reduces congestion (Lewis and Williams 1999; Litman 2006b).[1]

- Adler and van Ommeren (2016) analyzed the impacts of citywide public transit strikes in Rotterdam, in The Netherlands. They found that a strike causes only marginal weekday congestion increases on the highway ring road (0.017 minutes per kilometer) but substantially on inner city roads (0.224 minutes per kilometer) with larger impacts during rush hour and virtually no impacts on weekends. They calculate that public transit's congestion relief benefit is equivalent to about half of its subsidy.
- Highway traffic speeds declined and rush hour duration increased significantly during the 2003 Los Angeles transit strike, despite just 6.6% transit commute mode share (Lo and Hall 2006).
- Winston and Langer (2004) found that U.S. cities' congestion costs decline as rail transit mileage expands, but increase as bus transit mileage expands, apparently because buses have lower automobile substitution rates, contribute to congestion, and do little to increase land use accessibility.
- Garrett (2004) found that congestion growth declined in after rail service was established.
- Baum-Snow and Kahn (2005) found significantly lower average commute travel times in areas near rail transit stations than in otherwise comparable locations without rail.
- Traffic volumes decreased 6.4% on a parallel highway after the Hiawatha rail line was completed, although regional traffic grew during that period (Kim, Park and Sang 2008).
- The Texas Transportation Institute data indicate that transit provides $279 annually per capita in cities with large rail transit systems (Litman 2004b). Figure 8 shows the much lower congestion delays in cities with high quality rail transit compared with similar size cities.

Figure 8 **Congestion Costs** (Litman 2004a, based on TTI 2003)



Matched-pair analysis indicates that cities with large rail transit systems have significant less per capita traffic congestion delay than similar size cities that have small or no rail transit. This suggests that rail transit significantly reduces congestion costs.

How Transit and HOV Reduces Traffic Congestion (Litman 2008)
When roads are congested, even reductions in traffic volumes can significantly increase travel speeds. For example, on a highway with 2,000 vehicles per lane-hour a 5% reduction in traffic volumes typically increases traffic speeds about 20 miles per hour and eliminates stop-and-go conditions (TRB 1994). Similar benefits occur on congested surface streets.

Urban traffic congestion tends to maintain equilibrium. If congestion increases, people change route, destination, travel time and mode to avoid delay, and if it declines they take more peak-period trips. Reducing the point of equilibrium is the only way to reduce long-term congestion. The quality of travel alternatives has a significant effect on the point of congestion equilibrium: If alternatives are inferior, few motorists will shift mode and the point of equilibrium will be high. If alternatives are attractive, motorists are more likely to shift modes, reducing the point of equilibrium. Improving travel options can therefore increase travel speeds for both those who shift modes and those who continue to drive.

To attract discretionary riders, transit must be fast, comfortable, convenient and affordable. Grade-separated transit (such as rail on separate right-of-way or busways) provides a speed advantage that can attract discretionary riders. When transit is faster than driving, a portion of travelers shift mode until the highway reaches a new equilibrium (that is, until congestion declines to the point that transit is no longer much faster). As a result, the faster the transit service, the faster the traffic speeds on parallel highways. Several studies find that door-to-door travel times for motorists tend to converge with those of grade-separated transit (Mogridge 1990; Litman 2006b). The actual number of motorists who shift to transit may be relatively small, but is enough to reduce delays. Congestion does not disappear, but it never gets as bad as would occur if grade-separated transit service did not exist.

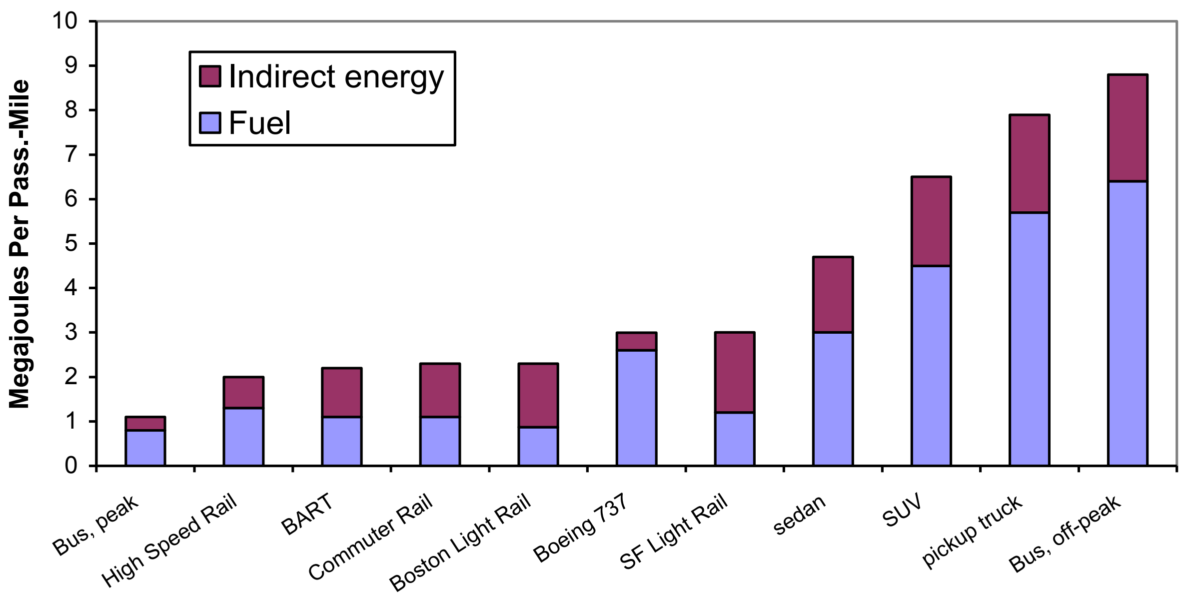
Energy Conservation and Emission Reductions

Critics argue that rail transit energy savings and emission reductions are small, based on comparisons of average energy consumption and emissions per passenger-mile. They conclude that these benefits are small compared with other energy conservation and emission reduction strategies, and so cannot justify rail transit projects. This analysis ignores three important factors:

- As previously described, high quality rail transit and transit-oriented development tends to leverage additional reductions in per capita vehicle travel, beyond just what shifts to rail, providing large additional energy savings and emission reductions. Residents of transit-oriented communities tend to consumer 20-40% less transportation fuel energy than they would in more automobile-oriented locations (ICF 2008 and 2010).
- Part of the reason that U.S. transit systems are not very energy efficient is because of operational inefficiencies and low load factors. Improvements such as grade separation, faster loading, ridership incentives, transit-oriented development can significantly increase transit energy efficiency and load factors, and reduce more automobile travel.
- Energy conservation and emission reductions are just two of many benefits provided by high quality transit. Although rail transit projects may not be justified based only on these two objectives, they are often very cost effective when all benefits are considered.

Figure 9 summarizes total lifecycle energy consumption and pollution emissions for various transport modes fuel used in operation and energy embodied in vehicle and facility construction and maintenance. The results indicate that public transit modes tend to be energy efficient and low polluting overall, typically using less than half the energy of a sedan and a quarter of the energy as a SUV or light truck. However, transit modes are sensitive to load factors: during peak periods, when load factors are high, buses are the most energy efficient mode, but during off-peak, when load factors are low, buses are least efficient. Described differently, transit policies that reduce average load factors by increase transit service to times and locations when demand is low (such as increasing fares or expanding service to suburban areas or late nights) reduces efficiency while policies that increase load factors (such as reducing fares, improving rider comfort, transit encouragement programs, and transit oriented development) tend to increase efficiency.

Figure 9 **Lifecycle Energy Consumption, Megajoules Per Passenger-mile**
(Aurbach, http://pedshed.net/?p=219, based on Chester and Horvath 2008)



This figure compares fuel and embodied energy (energy used for vehicle and facility construction and maintenance) for various transport modes.

Road and Parking Cost Saving

To the degree that high quality transit reduces automobile ownership and use it can provide road and parking facility cost savings. In general, reductions in vehicle ownership reduce residential parking costs, and reductions in vehicle trips reduce roadway costs and parking costs at destinations. These benefits tend to be particularly large because rail transit serves dense urban areas where road and parking congestion problems are often severe, and road and parking facility expansion is particularly expensive and difficult.

Most people seldom pay directly for roads and parking facilities and so have little idea of the costs of these facilities, or the magnitude of savings that result from reduced consumption. Overall, roadways construction and maintenance costs average 5-10¢ per vehicle-mile, but are far higher under urban conditions, urban highways often cost $1.00 per additional peak-period vehicle-mile accommodated ("Roadway Costs," Litman 2003a). Similarly, a typical urban parking space has a value of $500-1,500 annual, and there are typically three to six parking spaces per vehicle ("Parking Costs," Litman 2003a). Thus, a 10-30% reduction in per capita vehicle ownership and use by urban residents can provide hundreds of dollars a year in road and parking cost savings.

A survey of 17 transit-oriented developments (TOD) in five U.S. metropolitan areas showed that vehicle trips per dwelling unit were substantially below what the Institute of Transportation Engineer's *Trip Generation* manual estimates (Cervero and Arrington 2009). Over a typical weekday period, the surveyed TOD housing projects averaged 44% fewer vehicle trips than that estimated by the manual (3.754 versus 6.715). The rates varied from 70-90% lower for projects near downtown to 15-25% lower for complexes in low-density suburbs.

Some of these savings depend on local development policies. If zoning codes require generous parking supply, properly owners may be unable to capture the savings that result from reduced parking demand: parking spaces will simply be unoccupied. However, over the long run most parking spaces have opportunity costs, particularly in large urban areas: they can be used by other motorists, leased or rented, or converted to other uses, such as storage, building or gardens.

Economic Development

High quality rail transit supports economic development in several ways (Litman 2009).

- Vehicle and fuel expenditures tend to create fewer jobs and less business activity than spending on most other consumer goods, since they are largely imported (even if vehicles are assembled in a country, many of their components are imported). Since residents of communities with high quality transit tend to spend less on vehicles and fuel, this tends to increase employment and business activity. These benefits are likely to increase in the future as fuel prices rise and domestic fuel and vehicle production decline.
- Improved accessibility and household transportation cost savings.
- Reductions in congestion, road and parking, accident, and pollution damage costs tend to increase economic productivity and competitiveness.
- More compact, mixed development supports agglomeration efficiencies and reduces infrastructure costs.

Table 5 summarizes IMPLAN Input/Output model analysis that quantifies the national economic impacts of consumer fuel and vehicle cost savings. It indicates that, using 2006 economic conditions, a million dollars of fuel savings shifted to a typical consumer bundle of goods adds about 4.5 jobs to the U.S. economy, a million dollars shifted from other automobile expenditures (vehicles, servicing, insurance, etc.) adds 3.6 jobs, and if spent on public transit adds 19 jobs. These benefits tend to be much larger at the regional scale, since a portion of vehicle and fuel expenditures leave the region but stay in the country, and these benefits are likely to increase in the future as fuel prices rise and domestic fuel and vehicle production decline.

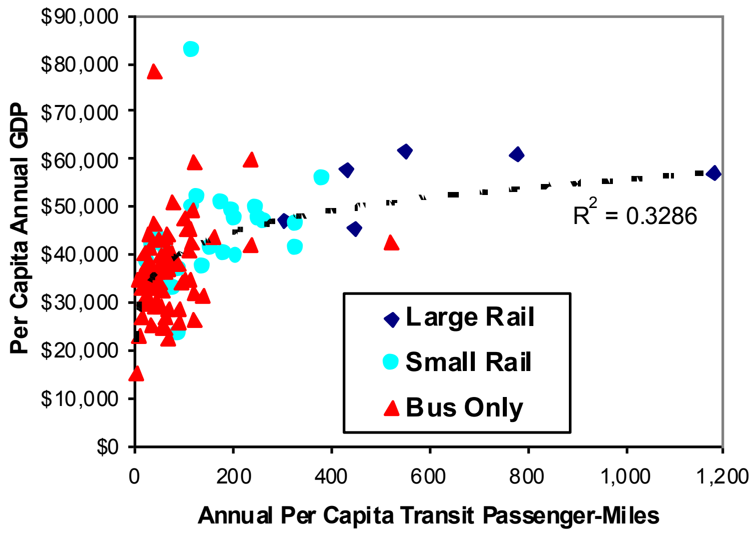
Table 5 **Economic Impacts per $1 Million Expenditures** (Chmelynski 2008)[2]

Expense category	Value Added	Employment	Compensation
	2006 Dollars	FTEs*	2006 Dollars
Auto fuel	$1,139,110	12.8	$516,438
Other vehicle expenses	$1,088,845	13.7	$600,082
Household bundle, with auto expenses	$1,278,440	17.0	$625,533
Household bundle, auto expenses redistributed	$1,292,362	17.3	$627,465
Public transit	$1,815,823	31.3	$1,591,993

A million dollars fuel savings adds 4.5 jobs, and a million dollars in general motor vehicle savings adds about 3.6 jobs, to the U.S. economy. (FTE = Full-Time Equivalent employees)*

In addition to the economic benefits from consumer expenditure shifts, rail transit tends to provide other economic benefits, described above, including user and external cost saving, improve land use accessibility, and agglomeration efficiencies. These tend to increase nearby property values (the capitalized value of transportation cost savings) and increase overall economic productivity. Although these impacts are difficult to quantify, their total impacts appear to be large. Figure 10 indicates that per capita Gross Domestic Product (GDP, an indicator of economic productivity) tends to increase with transit travel and is particularly high in cities with high quality rail transit systems. In contrast, Figure 8 indicates that per capita GDP declines with increased roadway supply, an indication of automobile-oriented transport systems and sprawl.

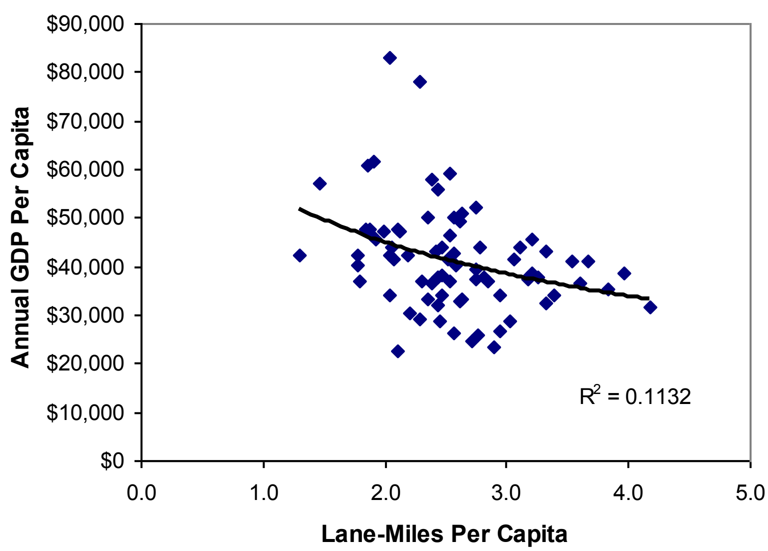
Figure 10 **GDP Versus Transit Ridership** (Litman 2009)



GDP tends to increase with transit travel due to various economic savings and benefits.

Of course, other factors contribute to the higher productivity of rail transit cities: transit ridership tends to increase with city size and density, but by supporting these factors rail transit contributes indirectly to productivity gains. As a result, high quality transit can contribute significantly to economic development.

Figure 11 **Per Capita GDP and Road Lane Miles** (VTPI 2009)



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

Improved Accessibility For Non-Drivers

Rail transit can help improve accessibility for people who, due to disability, poverty, or legal constraints, cannot drive an automobile:

- Many low incomes people rely on rail transit and benefit from its relatively high service quality compared with conventional bus transit.
- Rail and bus transit are complements. As rail transit expands so does bus service due to increased demand and funding.
- Transit-oriented development increases land use accessibility and modal integration that benefits non-drivers, with improved walking, cycling and taxi services; more accessible land use development, and more socially acceptability of alternative modes.

These savings and benefits can be substantial. Non-drivers located in areas with high quality transit service tend to have substantially better overall accessibility and spend substantially less on transport than residents of more automobile-oriented communities. Transit systems can be designed to maximize benefits to disadvantaged people by applying universal design standards (so facilities and vehicles accommodate travelers with special needs, such as wheelchair users and limited vision), making fares affordable, providing service on corridors used by lower-income travelers, and including affordable housing in transit-oriented developments.

Other Economic Benefits Ignored By Critics

Critics generally ignore other important economic benefits of high quality transit, and therefore underestimate rail investment cost efficiency (Litman 2008).

- *Consumer savings.* As previously described, high quality rail transit tends to provide significant transportation savings, which alone can often repay incremental costs. On average, residents of cities with high quality rail transit spend an extra $100-200 on transit subsidies but save about $500 in reduced transportation expenditures. These savings are equivalent to increased income, particularly for lower-income households.
- *Accident reductions.* Residents of communities with high quality rail transit tend to have significantly lower per capita traffic casualty rates than in automobile-dependent communities. These safety benefits are generally overlooked, although it is one of the largest categories of economic benefits.
- *Public fitness and health benefits*. Since most transit trips involve walking and cycling links, and transit-oriented development improves walking and cycling conditions, rail transit tends to improve public fitness and health.

Transit Is Slow and Inefficient

Critics argue that transit is slow and inefficient, based on comparisons of average transit and automobile travel speeds. This ignores important factors:

- *Geography.* Commute distances, congestion delays, and rail transit all tend to increase with city size, so it is unsurprising that cities with rail transit have relatively intense congestion and long commute duration. But this does not mean that rail transit causes these effects.
- *Travel speeds.* Although overall, transit travel tends to be slower than driving, particularly buses in mixed traffic, grade-separated service is often faster. For example, transit is often faster than driving between Brooklyn and Manhattan, or Oakland and San Francisco. In addition, high quality transit reduces traffic congestion, which increases travel speeds for all modes on these corridors. The additional travel time required for public transit results from the additional walking and cycling required: transit users spend a median of 19 daily minutes walking, which nearly achieves the 22 daily minutes of moderate physical activity required for health (Besser and Dannenberg 2005). Conventional transport planning assumes that this additional time is a cost, but many people enjoy walking and cycling, and value their health benefits, so this time can be considered a benefit rather than a cost, by avoiding the need to devote special time to exercise (APHA 2010; CDC 2010).
- *Travel time unit cost.* Total travel time costs are the product of *travel time* (minutes or hours) multiplied by *unit costs* (cents per minute or dollars per hour). Travel time unit costs vary depending on conditions and preferences (Litman 2008). Time spent relaxing on a comfortable seat or walking under pleasant conditions generally has lower unit costs than time spent driving in congestion. Transit allows users to work, relax and exercise, making their travel time more productive (Wener, Evans and Lutin 2006). As a result, Unit costs also depend on traveler needs and preferences. For example, a person might one day prefer to use transit but another day need to drive. A transportation system that offers high quality walking, cycling and public transit, in addition to efficient automobile travel, lets travelers choose the best option for each trip, maximizing consumer benefits.
- *Low load factors.* Critics sometimes complain that "rail vehicles operate half empty." This may be true but does not necessarily indicate inefficiency. All vehicles are sized for peak loads and so often operate with extra capacity. Rail service tends to have higher load factors than buses and automobiles. For example, a 5-passengers that averages 1.6 driven one hour per day has a 1.3% overall average load factor ([1.6/5]/[1/24]). In comparison, a 65-passenger train carriage that averages 15 passengers operating 16 daily hours per day has a 15% load factor ([15/65]/[16/24]), more than ten times more efficient.
- *Operational Improvements*. Claims that transit is slow can justify service improvements such as grade separation, faster loading systems and transit-oriented development to increase speeds and accessibility.

Overall efficiency is maximized if transport systems offer diverse options so users can choose the best one for each trip. High quality rail transit is often more comfortable and less stressful than driving, which increases travel time productivity, and by attracting travelers who would otherwise drive on major urban corridors and stimulating more compact development, helps reduce total transportation costs to users and society. Claims that transit is slow and inefficient can justify service improvements that further increase performance and system efficiency.

Transit Is Subsidized, Automobile Travel Is Not

Critics argue that transit is highly subsidized and automobile travel is not, implying that transit is inefficient, inequitable and unresponsive to consumer demands. This is untrue. Although transit is subsidized directly by taxes, automobile is even more subsidized by a combination of general taxes spent on roadways (which finance about half of U.S. roadway costs), subsidized parking (partly public, and partly private in response to government mandates), and through various uncompensated external costs such as accident risk and pollution damages (Murphy and Delucchi 1998; Litman 2003a). Comparisons of these subsidies depend on how they are measured.

- *Direct government subsidies* (transit service and roads) per passenger-mile tend to be higher for transit than automobiles, and for bus transit than for rail transit.
- *Total subsidies* (transit service, roads and parking facilities) per passenger-mile tend to be somewhat higher for transit than for automobile overall, but are comparable under urban-peak conditions high transit load factors, and high road and parking facility costs.
- *Subsidies* needed to accommodating additional urban travel is often less for transit than for automobile if roads are congested and transit systems have excess capacity, either within existing vehicles or on existing rail lines.
- *Per capita subsidies* are generally higher for motorists than for transit users because they travel far more annual miles (typically 10,000 to 15,000 annual miles for motorists compared with 1,000 to 3,000 annual passenger-miles for transit dependent people.

Public transit subsidies are often justified on the following grounds:

- *Equity.* Transit and transit-oriented development tend to improve accessibility for non-drivers, and so achieves vertical equity objectives. Automobile travel is subsidized through free roads and parking facilities, so transit subsidies can also be justified on horizontal equity grounds, to give non-drivers a fair share of resources.
- *As a second-best strategy to offset another market distortion.* Until automobile travel is efficiently priced with appropriate road, parking, fuel and emission fees, transit subsidies can be justified reduce excessive congestion, road, parking, accident and pollution costs.
- *Due to economies of scale.* Rail transit experiences scale efficiencies: unit costs tend to decline with increased ridership. This cost structure justifies subsidies.
- *To help achieve a strategic planning objective.* Rail transit can provide a catalyst for more efficient land use and economic development.
- *Increased land values.* Proximity to rail transit tends to increase property values tax revenues (Smith and Gihring 2004). These represent the capitalized value of future transport and parking cost savings to residents and businesses, and productivity gains from improved accessibility and agglomeration efficiencies (Litman 2008). Rail subsidies can be justified to achieve these savings and benefits.

Critics often claim that rail transit receives an excessive portion of transportation budgets, for example, if a city with 5% transit mode share invests 40% of its capital budget on transit improvements, but this is often justified:

- Although rail carries only a small portion of total travel, it serves corridors with severe congestion, parking and pollution problems, where road expansion is particularly costly.
- Rail projects generally include tracks, trains, stations, parking, and amenities that provide additional benefits besides mobility. Rail is relatively less costly considering all costs.
- Rail projects may seem high during periods of expansion, but are smaller when averaged over facilities' operating life.

Rail transit actually represents a small portion of total transport expenditures. U.S. in 2000 rail transit subsidies (expenditures minus fares) totaled $12.5 billion, compared with $103 billion spent on roads and an estimated $200 billion spent on non-residential parking (Litman 2003a). Rail subsidies therefore represent less than 10% of road and transit expenditures, and less than 5% of road, transit and parking expenditures.

From a household's perspective, rail transit investments are worthwhile: Quality rail service requires about $95 annually per capita in additional public subsidy but provides direct transport cost savings that average about $450 annually, a 500% annual return on investment (Litman 2004a). Rail transit also tends to increase regional economic development by reducing congestion, fuel and vehicle import costs.

Transit Provides No Energy Savings

Kimball, et al. (2013) performed a comprehensive life-cycle energy and environmental impact assessment of the Phoenix light rail system, taking into account both direct impacts, and indirect impacts from more compact on embodied resources for vehicle and building production, and travel activity. The results indicate significant potential energy savings, and both local and global (greenhouse gas) emission reductions from more transit-oriented development, as well as economic and local "livability" benefits including increased affordability and urban redevelopment. It concluded that marginal benefits from new rail services are likely to significantly exceed marginal costs.

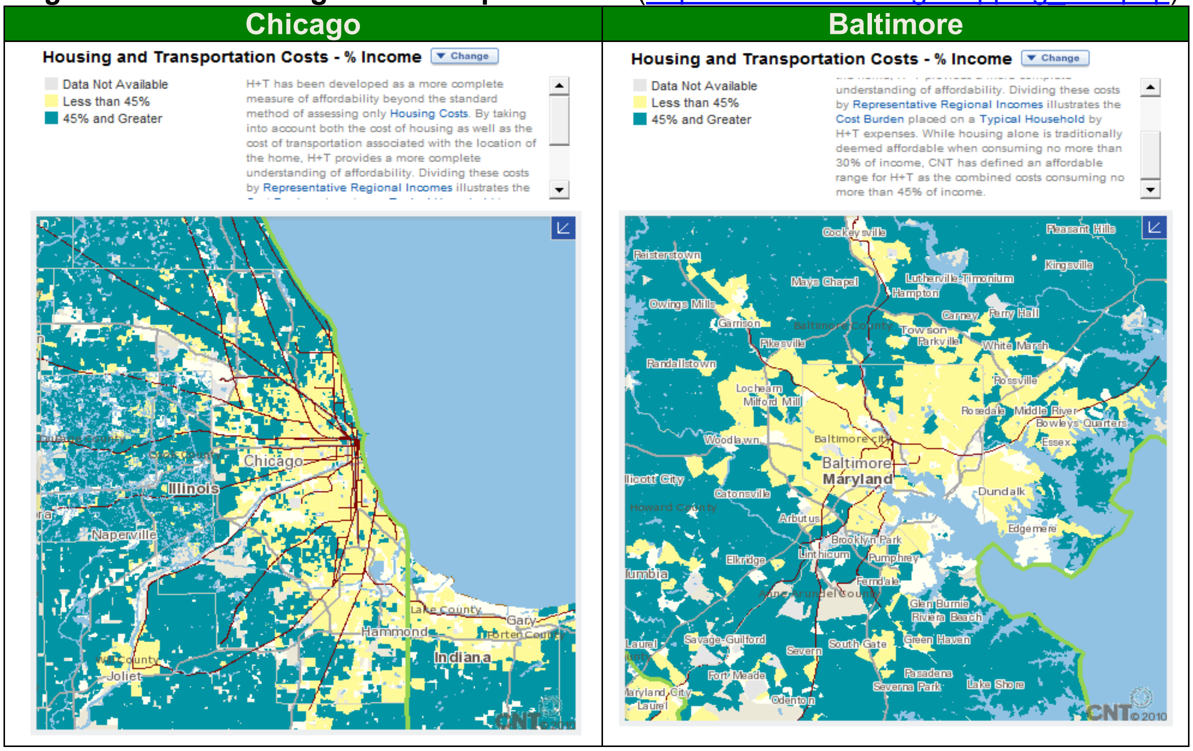
Rail Transit Harms Poor People

Because rail tends to attract a greater portion of higher income riders than buses, critics argue that rail investments are regressive, and that poor people could benefit more from bus improvements or subsidized automobile ownership. This ignores important factors:

- Despite relatively high average incomes, high quality rail transit systems carry diverse passengers including many with low incomes.
- Rail investments often substitute for road expansion rather than bus service, and since voters tend to support rail more than bus, rail projects often increase total transit funding.
- Rail and bus transit are complements. As rail transit systems expand, so do bus services due to increased demand and funding.
- Transit-oriented development creates more accessible, multi-modal communities which significantly benefits non-drivers.
- Subsidized automobiles only help transit users who can drive but cannot afford a vehicle, and imposes thousands of dollars annually for fuel, insurance, registration, maintenance and repairs, parking and traffic citations, plus bear additional crash risk.
- Increased vehicle ownership increases external costs such as congestion, accident and pollution. Low-income people tend to be particularly vulnerable to such impacts.
- Although access to a car increases employment opportunities, so does access to high quality public transit (Sanchez 1999; Yi 2006).

Critics also argue that transit-oriented development increases housing costs and reduces affordability for lower-income households. This is generally not true. Although housing costs are often higher in urban areas, total housing and transport costs tend to be lower (CNT 2010). Figure 12 shows two images from the *Housing and Transportation Affordability Index Mapping Tool*. They indicate that combined housing and transport costs tend to be lower in urban areas, particularly along rail corridors.

Figure 12 **Housing And Transport Costs** (http://htaindex.cnt.org/mapping_tool.php)



Combined housing and transport costs tend to be lower along rail transit lines.

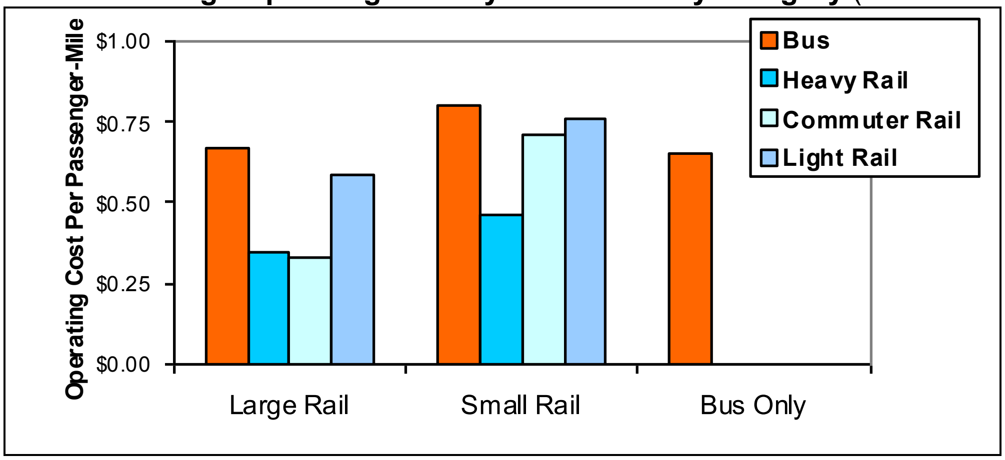
Various transit-oriented development policies can further increase affordability:

- More flexible zoning restrictions to allow more development density, height and mix.
- Build more affordable housing (basic small lot single-family, townhouses and apartments) near transit stations.
- Reduced and more flexible parking requirements, and unbundle parking (rent parking separately from building space, so occupants only pay for spaces they actually want).
- Improved walking and cycling conditions.
- Mixed land use, with special efforts to locate commonly-used public services (schools, parks, stores, health care services, restaurants, etc.) in residential neighborhoods.
- Support for local carshare and taxi services.
- Cost-based development and utility fees to reflect the lower costs of providing public services in more accessible locations, with reductions for zero-vehicle households.

Bus Transit Is Cheaper Than Rail

Critics often argue that buses can provide comparable service quality more cheaply than rail, but this is often untrue. Rail transit generally has lower operating costs per passenger-mile than bus service, as indicated in Figure 13. Basic bus systems generally have lower capital costs than rail because they lack features such as grade separation, attractive stations and local pedestrian improvements. As a result, basic bus transit systems provide inferior quality service, attract fewer discretionary travelers, do less to stimulate transit-oriented development, and therefore provide smaller benefits than rail transit systems. As bus service is improved to achieve these benefits, with grade separation and nicer stations, its costs tend to increase toward that of rail.

Figure 13 **Average Operating Cost By Mode and City Category** (Litman 2004a)



Rail operating costs tend to be lower than for bus.

Rail and bus each have advantages and disadvantages, so each is suitable for certain situations (Litman 2008). Rail tends to provide faster service, more comfortable vehicles and stations, better integration with other modes and land use, and more prestige than buses (Demery and Higgins 2002; LRN 2006). Rail is therefore most appropriate on major corridors where demand is high, where compact development is desirable, and where heavy bus traffic would cause noise and air pollution problems. Bus is most appropriate serving dispersed destinations and where transit supportive development polices cannot be implemented. Bus Rapid Transit (BRT) systems can provide some of these amenities, including grade separation, and more comfortable vehicles and stations, but this raises their costs closer to that of rail (Wright 2007).

Critics sometimes claim that rail transit requires very high population densities (often reported at 75 residents per acre) and highrise housing, and can only serve downtowns. These are exaggerations. Rail can function efficiently with densities as low as 25 residents (about 10 housing units) per acre, which can be achieved with a combination of single-family and mid-rise multi-family housing (Pushkarev and Zupan 1977). Rail can connect various destinations, including business districts, sports and cultural centers, campuses, shopping malls, and suburban residential areas.

Critiquing Rail Transit Critics

This section examines specific rail transit criticisms. Also see CFTE (2005), Parry and Small (2007) and Litman (2011).

Washington's War on Cars and the Suburbs

A paper by Wendell Cox (2010) titled, *Washington's War on Cars and the Suburbs: Secretary LaHood's False Claims on Roads and Transit*, criticizes USDOT rail transit investment plans, claiming that rail transit benefits are unproven and exaggerated. It criticizes my report, *Rail Transit In America: Comprehensive Evaluation of Benefits* (Litman 2004a), the source of many of the Secretary's assertions. Cox's criticisms are evaluated below (Litman 2011)

Insufficiently Vetted and Outdated?

Cox criticizes *Rail Transit In America* for being "insufficiently vetted and dated," although the report was peer reviewed, and summary articles based on this research were published in the U.S. National Academy of Science's *Transportation Research Record* (Litman 2005b) and the professional journal *Transport Policy* (Litman 2007).

It is true that the report is now six years old and based on older data, but the basic relationships found in that study are durable, and many of the impacts and benefits identified are likely to increase due to demographic and economic trends that are increasing demand for alternative modes and transit-oriented development, such as aging population, rising fuel prices, increasing urbanization, and increased health and environmental concerns. Many studies on which Cox bases his analysis are far older.

A War On Cars and Suburbs?

Cox is wrong to suggest that the USDOT's policies represent a *war* on automobiles and suburbs. Rail transit and smart growth policies do not harm motorists; as previously described, motorists often benefit overall from reduced congestion, accident risk and chauffeuring burdens. Similarly, many suburbs benefit from rail services and smart growth policies. Even with USDOT policy changes, the majority of federal transportation planning and investment resources are devoted to highways.[3]

The USDOT's policy changes respond to demographic and economic trends which are increasing consumer demands for alternative modes and smart growth communities, including aging population, rising future fuel prices, increased traffic congestion, growing health and environmental concerns, and changing consumer preference (Litman 2005a; Myers and Ryu 2008; Reconnecting America 2004).

Cox claims that, "People are free to choose cars or transit for their travel, and the car tends to be preferred by those who can afford it." This is not true. Most US communities lack high quality transit, leading to low ridership, but as previously described, where quality transit exists its mode share is five to ten times higher than the U.S. average, indicating significant latent demand. Only if high quality transit is available can travelers choose the option that best meets their needs for each trip and indicate the true level of consumer demand for such service.

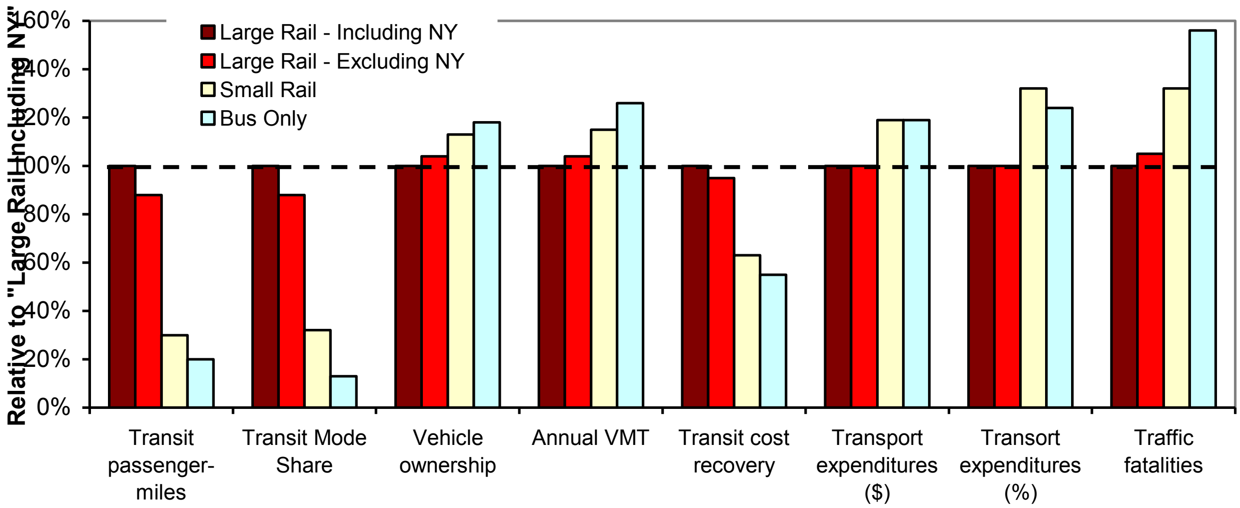
Analysis Methodology

Cox argues that, "The APTA report sets up a 'straw man' to suggest how costs would differ in urban areas if rail transit service did not exist." This is wrong. *Rail Transit In America* compares actual transportation system performance between U.S. cities that have high quality rail with those that do not, using standard statistics such as congestion costs, accident rates, consumer spending and transit cost recovery. It does not speculate on how such impacts would change in particular cities if rail service did not exist.

New York City's Influence

Cox argues, "APTA's large-rail urban-area classification is principally a measure of rail's impact in New York City (not the New York urban or metropolitan areas) rather than in large-rail urban areas outside New York." This statement is untrue. Because critics made this claim, soon after *Rail Transit In America* was released I reanalyzed the data excluding New York and published the results in subsequent report versions. The results, summarized in Figure 14 indicate that in no case does including New York significantly affect results and conclusions. With and without New York, the "Large Rail" cities experience substantially higher transit ridership and cost recovery, reduced vehicle ownership and mileage, substantial consumer savings, and much lower traffic fatalities.

Figure 14 **New York Impacts on Analysis Results** (Litman 2004a)



Critics claim that rail transit benefit analysis is distorted by including New York City, but excluding New York (light red versus dark red) actually has little effect on results.

Geographic Definitions

Cox argues that, "APTA is imprecise and inconsistent about what it means by 'city,' which, depending on the element of analysis, may be 'metropolitan area,' 'urban area' (urbanized area), or a core municipality, each of which has a distinct meaning. Valid research requires appropriate labeling."

It is true that statistics used in *Rail Transit In America* vary geographically. For example, FHWA *Urban Areas* differ from U.S. Census *Metropolitan Statistical Areas*, which differ from FTA *Transit Service Areas*. However, these differences are indicated in the report and its references. Cox is correct that in some cases it would be more accurate to use the term *metropolitan region* rather than *city*, but the word *city* is often used for metropolitan regions in such situations, for example, in the Texas Transportation Institute's *Urban Mobility Study*. As Cox points out, the study uses *core municipality transit mode share* to categorize cities' rail quality, but this makes sense since rail service is concentrated in central areas. Using regional instead of central city mode share would not change the resulting categorizations so the criticism is irrelevant.

Economic Impacts
As previously described, rail transit helps support economic development several ways: it increases overall accessibility; reduces various economic costs (traffic congestion, road and parking costs, accident damages, pollution, etc.); helps create more compact land use development that achieve agglomeration efficiencies; and shifts consumer expenditures toward goods with greater regional input; and reduces oil vulnerability and trade deficits. This helps explain why rail transit cities tend to have much higher per capita GDP than average, as illustrated in Figure 10.

Cox argues that the economic benefits of rail transit are minuscule but subsequent analysis indicates these benefits are even larger than originally estimated. *Rail Transit In America* used Input/Output analysis to quantify the increased regional employment and business activity that results when high quality transit allows consumer to shift their spending from vehicles and fuel to other goods with greater local input. Cox legitimately points out that the 1999 study used as the basis for calculating these economic impacts in *Rail Transit In America* is dated and limited because it reflects a single urban region (it was the only study of its type available at the time). However, more recent studies show similar results. As previously described, a million dollars of fuel savings shifted to a typical consumer bundle of goods adds about 4.5 jobs to the U.S. economy, a million dollars shifted from other automobile expenditures (vehicles, servicing, insurance, etc.) adds 3.6 jobs (Chmelynski 2008; for more discussion see Litman 2009).

Consider the impacts in San Antonio, as Cox does. In 2005, U.S. consumers spent an average of $3,500 annual on vehicles and fuel (BLS 2007). The San Antonio metropolitan area has about 2.0 million residents, so regional consumers spend about $7.0 billion annually on vehicles and fuel. If high quality transit can reduce these expenses 20%, as it does in other urban regions, the $1.4 billion annual consumer savings would increase domestic employment by about 5,600 jobs, with larger gains at the regional level, and these benefits should in the future as petroleum prices rise.

Of course, developing high quality transit service in San Antonio would require significant service improvements. Cox estimates that doubling San Antonio's transit ridership would require $150 million in additional annual expenditures, which seems large compared with current transit funding but is only 1-2% of current regional spending on vehicles (about $3,500 per capita, $7.0 billion total), roads (about $500 per capita, $1.0 billion total) and parking facilities (about $2,000 per capita, $4.0 billion total).

Energy Conservation and Emission Reductions
Cox argues that rail provides only modest energy savings and emission reductions compared with driving a modern, fuel efficient car, based on comparisons of fuel consumption rates per passenger-mile. However, as previously discussed, this ignores the much larger energy savings and emission reductions indicated by lifecycle analysis which accounts for upstream and embodied energy (Chester and Horvath 2008, see Figure 9 of this report), and the energy savings that result from reductions in total per capita vehicle travel. As described in the first

section of this report, residents of transit-oriented communities typically drive 20-40% less than in automobile-dependent communities, and so consume that much less fuel (ICF 2008 and 2010).

Congestion Reduction, Accessibility and Economic Development

As previously discussed, numerous studies indicate that high quality, grade separated transit significantly reduces traffic congestion by offering travelers a relatively fast and comfortable alternative to driving (Lewis and Williams 1999; Litman 2006b). Cox uses one of his own previous studies to conclude that public transit provides little congestion reduction benefit (Cox and O'Toole 2004). This analysis makes various previously described errors:

- He measures congestion using the *travel time index* and the INRIX *traffic congestion scorecard*, which measure traffic congestion intensity experienced by motorists, but ignore delays avoided when travelers shift to grade separated transit and from reduced travel distances due to more compact development. *Per capita congestion costs* is the more appropriate indicator of transit congestion reduction benefits.
- He uses overall *average* travel speeds rather than *actual* speeds on major urban corridors with grade separated transit service. Grade separated transit is often faster and less stressful than driving under such conditions.
- He fails to account for the larger average size of cities with high quality rail transit, which tends to increase congestion intensity and average travel distances.
- He only considers commute travel times, although commuting represents only about 20% of total travel. Automobile dependency and sprawl increase travel distances, congestion and travel costs for all types of trips, and therefore total travel costs.

Consumer Savings

Cox criticizes the consumer cost analysis in *Rail Transit In America* because it is based on the Bureau of Labor Statistic's *Consumer Expenditures Survey*. He relies instead on the *ACCRA Cost of Living Index*, which is designed to, "compare cost of living differences among urban areas based on the price of consumer goods and services *appropriate for professional and managerial households in the top income quintile*" [emphasis added]. This indicates that high-income households, New York and Chicago have higher living costs than smaller cities.

Cox never mentions that his analysis is skewed to high income households and is therefore inappropriate for evaluating impacts on normal consumers.[4] This is either a significant oversight or an intentional misrepresentation.

Travel Time Costs, Consumer Preferences and Economic Productivity

Much of Cox's criticism is based on the assumptions that transit travel is always slower and less desirable than driving. He aggregates data, for example, by comparing overall average commute times for all transit modes (including buses in mixed traffic and longer-distance commuter rail) with driving, rather than comparing rail with driving to the same destination. Although transit tends to be slower *on average*, on major urban corridors, grade separated rail transit it is often faster than driving, for example, between Brooklyn and Manhattan, Oakland and San Francisco, or Cambridge and Boston.

Even when slower, travelers often prefer high quality transit because they can use their travel time productively (to work, read or rest), it is less stressful than driving, and they enjoy the walking links of transit trips.[5] For example, New Jersey train commuters report less stress and fewer negative moods than auto commuters (Wener, Evans and Lutin 2006). Similarly, a U.K. survey found that many rail passenger use their travel time for working (30% sometimes and 13% most times), reading (54% sometimes and 34% most times), resting (16% sometimes and 4% most times) and talking (15% sometimes and 5% most times), particularly during business travel (Lyons, Jain and Holley 2007).

Cox summarily dismisses the possibility that transit travel is ever more productive or preferable to driving. He states, "riders of the nation's largest rail transit systems (such as the New York subway and the Chicago El) routinely encounter overcrowded conditions during peak periods, with riders forced to stand." This is wrong. Although a portion of peak-period rail passengers stand, overall most transit passengers have seats.

This is not to suggest that everybody prefers transit for all trips, but high quality, grade separated rail transit is exactly the type of service that can provide travel time savings and user comfort on congested urban corridors. If such service is available travelers can choose the best mode for each trip: transit for some and driving for others. This increases user benefits, and by reducing traffic problems, provides external benefits. Cox's criticism therefore supports rail transit improvements to increase user and social benefits.

Cox builds on his assumption that transit travel is always slower and less desirable than driving to argue that rail transit cities are less productive and provide less economic opportunity to disadvantaged people, and that poor people are better off with subsidized cars. These claims are inaccurate and illogical:

- Although, as Cox points out, there is good evidence that improved employment access increase productivity, this applies equally to transit.[6]
- Although economically disadvantaged workers can benefit from access to a car, they also benefit from access to high quality public transit (Sanchez 1999; Yi 2006).
- Many disadvantaged people physically or legally cannot drive, and those who can drive often choose high quality public transit, if available, to save money.
- As described previously, empirical evidence indicates that rail transit cities have higher per capita GDP than cities with lower quality transit, indicating that Cox is wrong.

Roadway Savings

Cox argues that estimated road and parking cost savings are exaggerated because the assumed 60% automobile substitution rate (the portion of transit trips that substitute for automobile trips) is too high. He claims that there is little data available and so uses the following approach to estimate the Washington DC substitution rate:

> "From 1975 to 2006, the number of people commuting into the core rose 18 percent, while the number of cars entering the core rose nearly as much, at 15 percent. If it is assumed that car volumes would have increased at the same rate as commuters without Metro, then Metro reduced car traffic by approximately 5,300 vehicles."

This analysis is neither logical (a major portion of downtown Washington DC vehicle trips are not for commuting) nor necessary. As previously described, numerous surveys indicate that rail transit automobile substitution rates often exceeding 60% (APTA 2007; CTS 2009), and rail transit leverages additional vehicle ownership and travel reductions by stimulating transit oriented development. Rail services are concentrated in dense urban corridors where road and parking facility costs are particularly high so the economic savings from reduced traffic are particularly large. For these reasons, actual road and parking cost savings are probably even larger than indicated in *Rail Transit In America*.

Traffic Accident Costs[7]

Cox dismisses the safety benefits provided by high quality public transit and transit oriented development by arguing that, "people overwhelmingly choose to commute by car rather than by transit. Secretary LaHood's accident cost claims ignore the reality that switching from cars to transit would lower the standard of living for most people because transit is so much slower and often does not go where they need to go."

This argument is incorrect and illogical. As previously described, where high quality transit service exists many travelers choose it, and it increases economic productivity. Good public policy and responsible behavior generally favor safety over speed, for example in roadway design, traffic speed regulation, and driving activity. It would be foolish to ignore the large safety benefits rail transit provides, as Cox suggests.

Rail Versus Bus

Cox claims (footnote 4), "Oddly, it appears that a principal objective of the APTA report is to demonstrate the ineffectiveness of buses as a mode of transport. (footnote 4).
This is not true.[8] *Rail Transit In America* includes a section titled "Rail Versus Bus Transit" which discusses the advantages and disadvantages of each mode. It concludes:

> This is not to degrade bus transit. Rail and bus are complementary; rail is only appropriate on major corridors and relies on bus transit as feeder service. Bus systems can be designed with many of the attributes that attract discretionary travelers (grade separation, attractive vehicles, attractive stations that provide a catalyst for transit oriented development), and so can provide congestion, accident and emission reduction benefits. Many of the transit encouragement strategies encourage bus as well as rail ridership.

Transit Cost Efficiency

Cox argues that public transit is inefficient and excessively subsidized. He claims, "The federal transit subsidy per 1,000 passenger miles amounted to $166 in 2006, while federal highway revenues produced a net profit of $1.21 per passenger mile" [this appears to be an error, he probably means per 1,000 passenger-miles]. While this data is accurate it is incomplete, considering just federal expenditures. Only about half of total roadway expenses are paid by user fees (Subsidy Scope 2009), and considering both road and parking subsidies, automobile subsidies are much greater.

As previously described, it is generally inappropriate to compare costs and subsidies between public transit and automobiles per passenger-mile for the following reasons:

- Rail transit systems include rails, stations and trains, while automobile travel requires roads, parking and vehicles. Rail transit serves congested urban corridors where transport facilities tend to be particularly costly. For efficiency analysis, rail transit costs should be compared with the total road, parking and vehicle costs in congested urban corridors.
- Motorists tend to drive far more annual miles than transit users, so motorists tend to receive more annual subsidy than people who rely primarily on transit. For equity analysis, subsidies should be compared per capita, not per passenger-mile.
- Rail transit systems have higher load factors, lower operating costs per passenger-mile and higher cost recovery than bus transit. As a result, Cox's criticism of transit system inefficiency is actually an endorsement of high quality transit.

Smart Growth Impacts On Housing Affordability

In a box titled "Why the Cost of Living Is Higher in Large-Rail Metropolitan Areas," Cox argues that the smart growth policies associated with rail transit development make cities unaffordable. To support this claim he cites five papers, four published by his organizations and one by the World Bank, which argue that *prescriptive land-use regulations* significantly increase housing costs. This misrepresents the issues.

Cox assumes that smart growth increases *prescriptive land-use regulations*. In fact, smart growth increases some regulations but reduces others. It may regulate urban expansion but reduces many other regulations that restrict building density, height, setbacks and mix, and minimum parking requirements which tend to reduce housing costs by reducing land requirements and construction costs per housing unit. Academic studies indicate that smart growth has mixed or positive impacts on housing affordability (Nelson, et al. 2002). As previously discussed by reducing transportation costs, smart growth tends to reduce combined housing and transport costs (CNT 2010).

Much of the empirical evidence indicating higher housing costs in transit-oriented, smart growth communities reflects increased consumer demand and inadequate supply. This suggests that the best way to increase overall affordability, including housing and transport, is to significantly increase housing supply in areas served by high quality public transit (Reconnecting America 2004).

Summary

Evidence from various sources, many of them peer reviewed, indicates that high quality rail transit helps create more accessible, multi-modal communities where people own fewer cars, drive less and rely more on alternative modes, providing various direct and indirect benefits. *Rail Transit In America* uses standard statistics to quantify these impacts in U.S. urban regions. Cox's criticism of this study violates basic principles of good scholarship and debate (Litman 2004c). He misrepresents issues and data, ignores impact categories, and relies largely on studies that lack peer review. Much of his criticism is based on the false assumptions that rail transit is always less efficient and desirable than driving. The table below summarizes his conclusions (first two columns), and my critique (right column).

Table 6 **Critique of Cox's Conclusions** (Litman 2011)

Issue	Cox's Criticism	My Critique
Vehicle travel impacts	Public transit, particularly new rail systems, cannot attract motorists	Numerous studies indicate that high quality transit does attract discretionary travelers, and with supportive land use policies will leverage additional VMT reductions. Cox's evidence is weak and ignores leverage effects.
Cost efficiency	Public transit has excessive costs and declining cost efficiency (increasing cents per passenger-mile).	High quality transit has high construction but lower operating costs than basic transit, and provides many benefits which offset any additional costs. Cox exaggerates transit costs and ignores many benefits.
Consumer preferences	Most people prefer automobile travel and automobile-dependent communities.	Many people cannot drive and current demographic and economic trends are increasing demand for alternative modes and transit-oriented development. Providing high quality public transit responds to this demand.
Economic benefits	Purported benefits are minuscule and unachievable, and offset by additional transit service costs.	Cox only considers a small portion of transit economic benefits. Subsequent analysis indicates even greater benefits than originally estimated.
Energy savings	USDOE data indicate small differences between auto and transit energy use. Future cars will be even more efficient.	Cox ignores research on energy savings from vehicle travel reduction and reduced embodied energy.
Congestion cost savings	Work trip travel times are longer in large-rail metropolitan areas.	Many studies indicate that high quality, grade separated transit reduces congestion costs.
Consumer transportation cost savings	Transportation (and housing) costs are higher, not lower, in large rail metropolitan areas.	Many studies indicate that high quality transit provides large consumer savings, particularly for lower-income households. Cox uses data that ignore these impacts.
Road and parking savings	The estimates are invalid because they are based upon automobile driver attraction rates far beyond the levels indicated by experience.	Multiple data sources indicate that 50-80% of rail trips substitute for driving, and transit-oriented development reduces per capita vehicle ownership and use, providing road and parking facility cost savings.
Accident cost savings	Purported savings are insufficient to deter households from using cars to achieve important economic and other benefits.	This is a non-sequitur. Only if high quality transit service is available can people choose it, and experience indicates they will. Safety benefits are large and provide another justification for high quality transit.

The two left columns are from Cox's paper. The right column is my critique. Cox misrepresents issues and data, ignores impact categories, and relies largely on his own studies that lack peer review.

Great Rail Disasters

Randal O'Toole published *Great Rail Disasters* in 2004 to support his criticism of rail transit investments and smart growth policies.[9] The report applies the author's thirteen component index of transit impacts. But this index fails to reflect best practices for transit evaluation.[10] It makes a fundamental error by grouping together all cities with rail transit service, regardless of size. For example, it criticizes the New Orleans rail system for failing to solve the city's transport problems, although it is only a single rail line that serves a tiny portion of total regional transit trips. Accurate analysis must take into account the relative magnitude of rail systems.

O'Toole claims that rail fails to increase transit ridership, based on ridership trends between 1970 and 2000. But this indicates nothing about rail transit's effects since it includes no comparisons between cities or corridors with and without rail, or between rail cities and national trends. The only relevant evidence is the statement (which turns out to be false and has yet to be corrected) that,[11] "The twenty-three urban areas with rail transit collectively lost more than 33,000 transit commuters during the 1990s, while the twenty-five largest urban areas without rail transit collectively gained more than 27,000 transit commuters." These changes may reflect other factors unrelated to transit mode, such as the city's population and employment trends. Transit ridership grew in 18 of the 23 cities O'Toole analyzes, particularly those with expanding rail systems such as Denver (40%), Los Angeles (14%), Portland (59%), Sacramento (48%), San Jose (23%) and St. Louis (22%), indicating that rail transit investments often do increase ridership.[12]

Several demographic and economic trends increased automobile travel and reduced transit ridership during the 1970 to 2000 period, including growing vehicle ownership, baby boomers reaching peak driving age, more women in the workforce, and declining transit service. But many of these trends have peaked (Litman, 2005a), resulting in transit ridership growth most years since the mid-1990s. As described earlier, research by Baum-Snow and Kahn (2005) indicates that cities with rail systems experienced far smaller ridership losses than those that rely on bus transit.

O'Toole claims that rail is more costly than automobile or bus transportation, but his analysis contains several errors. He only considers a small portion of automobile costs and transit benefits when comparing modes: he overlooks vehicle costs, parking costs, accident damages and pollution emissions. O'Toole states incorrectly and without citation that regions with rail system devote 30-80% of their total transportation capital budgets to transit. When a major rail transit project is under construction most of the cost is included in a particular agency's capital budget, so for a few years it appears relatively large, but when averaged over a larger period (rail capital investments typically have 50+ year operating lives) these projects represent a relatively small portion of total transportation expenditures. O'Toole overlooks many benefits of rail, including improved mobility for non-drivers and urban redevelopment.

O'Toole significantly underestimates urban roadway expansion costs because he uses average costs rather than the much higher costs of roadway projects in congested urban corridors where most rail transit systems are built, and ignores costs for planning, land acquisition, and intersections. Current large city highway expansion projects are typically two to four times higher than O'Toole's estimates.[13] He is also wrong to compare road and rail based on *total daily* rather than *peak period* travel, since most urban roadways can handle travel demand except during peak periods. Accordingly, roadway capacity expansion costs should be assigned only to peak-period travelers (Litman, 2008).

O'Toole claims that rail increases traffic congestion, based on changes in the Texas Transportation Institute (TTI) *Travel Time Index* in cities with rail transit systems. But this indicates nothing about the effect of rail on congestion. Traffic congestion tends to increase with city size. Rail transit systems are generally developed as cities grow large enough to experience congestion problems, so cities with rail transit tend to have worse congestion than those without. However, this does not mean that rail transit *causes* congestion or fails to reduce congestion compared with what would occur without rail. O'Toole's methodology only considers congestion experienced by motorists, ignoring benefits to travelers who shift from driving to grade-separated transit, and when rail transit projects provide a catalyst for more accessible land use development which reduces total travel distances.[14] The TTI study provides seven congestion indicators, some of which are more appropriate for evaluating transit impacts. *Per-capita Congestion Cost* accounts for time savings that result from shifts to alternative modes and more accessible land use patterns (Litman, 2008). Measured in this way, congestion is found to decline substantially in cities with large rail transit systems, as illustrated earlier.

O'Toole argues that rail transit is dangerous based on relatively high crash rates per passenger-mile. Most of this risk is to other road users (pedestrians, cyclists and motorists), and it declines as load factors (transit passengers per vehicle) increase. Light rail crash rates per passenger-mile are far lower in other countries due to higher load factors and better integration of transit into urban design (Litman, 2004a). As with congestion, traffic accident risk is best measured *per capita* rather than per *passenger-mile*, since rail transit tends reduce total per capita vehicle travel.[15] Various studies indicate that per capita traffic fatality rates decline with increased per capita transit ridership (Litman, 2008). U.S. cities with large rail systems average 7.5 traffic fatalities per 100,000 population (7.9 excluding New York), while cities with smaller rail systems average 9.9, and cities that lack rail average 11.7, a 40% higher rate (Litman, 2004a).

O'Toole argues that rail transit reduces transit service quality and so harms transit-dependent residents by absorbing an excessive portion of transit funding. However, per capita funding for both rail and bus transit tends to increase, and transit ridership grows, as rail transit systems expand, indicating that rail and bus transit are complements, not substitutes (Litman, 2004a). This occurs because rail transit tends to attract support from middle-class citizens, and so tends to increase total transit funding. In addition, transit-oriented development provides other benefits to non-drivers, including improved walking conditions and less-dispersed destinations that are easier to access without a car.

O'Toole claims that rail transit projects are consistently over-budget and have lower ridership than projected, based primarily on a study performed in the late 1980s that used even older examples (Pickrell 1989 and 1992).[16] Although many of the examples are two decades old, O'Toole uses the present tense when describing them (e.g., "Pickrell reports that it went 61 percent over budget and carries less than a third of the anticipated riders"). Even when it was first published Pickrell's report was considered dated since planning reforms had already corrected many of the problems identified (APTA, 1990). Similarly, O'Toole reports fourteen-year-old data on airport rail transit use by air travelers, and only when this number is low. O'Toole provides estimates of cost overruns and rider shortfalls for various rail projects but includes no details. Researchers normally provide specific references and analysis in a report to allow independent verification. O'Toole's failure to provide this information indicates either carelessness or that he has something to conceal.[17] O'Toole ignores examples of more recent transit projects that have been on-time, on-budget and exceeded their ridership projections, as described earlier (Table 3.

O'Toole claims that rail transit uses more energy than automobile travel, and is not cost-effective for reducing pollution emissions. However, he compares transit energy consumption with *cars* (3,500 BTUs per passenger-mile) rather than the *automobile fleet average* (6,348 BTUs per passenger-mile, including light trucks, SUVs and vans) which is either an error or an intentional attempt to deceive. He fails to account for rail's ability to reduce total per capita vehicle travel and therefore emissions (Litman, 2004a and 2008). Although rail investments may not be justified on energy conservation and emission reductions alone, these can be considered valuable co-benefits. For example, if a community is choosing between expanding roadways or building rail in order to reduce traffic congestion, it makes sense to favor the rail option because it also reduces energy consumption and pollution emissions.

O'Toole claims that transit-oriented development reduces housing affordability, but this depends on how affordability is measured (Nelson, et al, 2002; "Affordability," VTPI, 2005). Rail transit projects are generally implemented in rapidly growing cities where property values are rising. There is no evidence that rail transit actually reduces housing affordability compared with what would otherwise occur. O'Toole also argues that zoning and other land use controls reduce housing affordability. This may be true, but the largest of these costs are minimum parking requirements and density restrictions to support automobile travel. Shoup (1999) found that parking costs average 4.4 times all other development charges combined, including fees for roads, schools, parks, water, sewage and flood control. Reduced parking requirements, increased housing diversity (allowing more multi-family developments and secondary suites), and location-efficient development (which reduces household transport costs) are smart growth ways to increase household affordability (Jia and Wachs, 1998; McCann, 2000; "Location Efficient Development," VTPI, 2005).

O'Toole's bias is revealed in its analysis of Portland, Oregon. According to his own indicators Portland's rail system is successful, with increasing transit ridership. Still, O'Toole arbitrarily concludes that Portland's rail system is a failure.

Summary: The Data Say Ouch!

Any evaluation involves numerous decisions as to which data to use, how to structure analysis, which results to provide, and how to present them. Statisticians joke that a researcher who manipulates analyses to reach a desired conclusion "tortures the data."

For example, consider congestion impact analysis. The Texas Transportation Institute's *Urban Mobility Study* has nine congestion indicators. Of these, the *Travel Time Index* is the least appropriate for evaluating rail transit benefits since it only considers delays to motorists. *Per capita Congestion Costs* takes into account reduced congestion delays to people who shift to transit or who travel shorter distances due to more accessible land use. In addition, the data can be evaluated in various ways, for example, using a single point in time, or trends over various time periods. Various cities can be selected and compared with each other or national trends. Results can be presented in total or per capita. A clever analyst can often find a combination of data and evaluation techniques that reflect the conclusion they want. The results are true but biased.

Several features of *Great Rail Disasters* analysis violate standard economic evaluation practices, indicating that the data were selected and analysis manipulated to support the author's desired conclusions.[18] These include:

- Lack of with-and-without analysis. There are virtually no comparisons between cities that have rail and those that do not. It is therefore impossible to identify rail transit impacts.
- Failing to differentiate between cities with relatively large, well-established rail systems and those with smaller and newer rail systems that carry a relatively small portion of regional transit ridership.
- Failing to compare individual city's trends with national trends.
- Failing to account for additional factors that affect transportation and urban development conditions, such as city size, changes in population and employment.
- Failing to apply marginal analysis. The report makes no effort to determine the incremental cost of accommodating additional peak-period travel by each mode.
- Ignoring many types of automobile costs. For example, vehicle expenses are included when calculating transit costs, but vehicle and parking expenses are ignored when calculating automobile costs.
- Exaggerating transit development costs. Claims, such as "Regions that emphasize rail transit typically spend 30 to 80 percent of their transportation capital budgets on transit" are unverified and generally only true for certain regions and years, not when costs are averaged over larger areas and times.
- Presenting outdated data as current, including examples from the 1960s through early 80's, and airport ridership data from 1990.
- Ignoring other benefits of rail transit such as parking cost savings, consumer cost savings and increased property values in areas with rail transit systems.
- Failing to apply current best practices in transit evaluation (as described in ECONorthwest and PBQD 2002, and Litman 2004).

Evaluating the Index

The Rail Transit Performance Index used in *Great Rail Disasters* is biased and ineffective. The table below describes changes needed to make it more accurate.

Table 7 **Rail Transit Performance Index**

"Great Rail Disaster" Indicators	Required For Accurate Analysis
1. Change in transit ridership from 1990 to 2000.	Rail systems should be categorized by their size relative to total transit ridership. Analysis should focus on the corridors served by rail, not total regional transit ridership. Should compare with national ridership trends. Continue to use most recent available data, such as 2002.
2. Change in transit share of motorized passenger travel from 1990 to 2000.	"
3. Change in transit commuting in the 1990s.	"
4. Change in transit's share of commuting in the 1990s.	"
5. Reliability of construction cost forecasts.	Categorize by year (e.g., pre-1990, 1990-1999 and 2000+) to see if predictions improved over time. Provide specific citations to allow independent verification.
6. Reliability of ridership forecasts.	"
7. Changes in congestion from 1982 to 2001.	Categorize rail systems by relative size. Use per capita congestion costs rather than a congestion index (which treats increased driving as a congestion-reduction strategy). Analyze individual rail corridors rather than total regional congestion.
8. Changes in per capita driving from 1982 to 2001.	Categorize rail systems by relative size. Analyze corridors served by rail. Compare with national trends. Continue to use most recent data, such as 2002.
9. Cost-effectiveness of rail transit relative to freeways.	Categorize rail systems by relative size. Analyze marginal rather than average costs, taking into account facility, parking and vehicle costs.
10. Cost-effectiveness of rail transit relative to buses.	Categorize rail systems by relative size. Compare marginal rather than average costs.
11. Safety of rail relative to autos and buses between 1992 and 2001.	Categorize rail systems by relative size. Compare *per-capita* traffic fatalities to account for the leverage effect rail can have on per capita vehicle travel.
12. Energy efficiency of rail relative to passenger cars in 2002.	Categorize rail systems by relative size. Compare *per capita* transport energy use to account for the leverage effect that rail can have on per capita vehicle travel.
13. Effects of rail transit on land-use regulation and property rights.	Recognize that many householders prefer to live in more multi-modal neighborhoods, and that TOD reduces many land use regulations, such as parking requirements, setbacks, and density limits.

This table recommends more appropriate indicators of transit system performance.

Point and Counter-Point With O'Toole

The week after the first version of this report was released, Randal O'Toole sent me the following comments. Below are my responses, in italics.

1. NEW YORK DISTORTS DATA

O'Toole: I like to say that the U.S. has two kinds of urban areas: New York and everywhere else. Nowhere else has a Manhattan with 52,000 people per square mile and (more important) 80,000 jobs per square mile. New York transit has more than twice the market share of the next leading region. Lumping New York in the transit data for any other group of urban areas (as you do in your discussion of "Large Rail cities" and elsewhere in your report) produces distorted results that are not reflective of other regions. Because New York is so large and because it produces more than 5 times as many transit rides as the next-highest urban area (and 38 percent of all transit rides in the U.S.), the averages you get from lumping it with other regions will be unrealistically high for any other region.

Litman: I recalculated the data (www.vtpi.org/transit.xls) to exclude New York. Below are examples to illustrate the point. In each case, excluding New York reduces the advantage of Large Rail cities by a modest amount, indicating that other Large Rail cities also enjoy significant benefits.

Annual Per Capita Transit Passenger-Miles	*Large Rail*	*Small Rail*	*Bus Only*
50 largest U.S. Cities With New York	*589*	*176*	*118*
50 largest U.S. Cities W/O New York	*520*	*176*	*118*

Annual Traffic Fatalities Per 100,000 Pop.	*Large Rail*	*Small Rail*	*Bus Only*
50 largest U.S. Cities With New York	*7.46*	*9.99*	*11.72*
50 largest U.S. Cities W/O New York	*7.90*	*9.99*	*11.72*

Per Capita Annual Congestion Costs	*Large Rail*	*Small Rail*	*Bus Only*
50 largest U.S. Cities With New York	*$551*	*$466*	*$397*
50 largest U.S. Cities W/O New York	*$561*	*$466*	*$397*

Percent Income On Household Expenditures	*Large Rail*	*Small Rail*	*Bus Only*
50 largest U.S. Cities With New York	*12.04%*	*15.81%*	*14.89%*
50 largest U.S. Cities W/O New York	*12.02%*	*15.81%*	*14.89%*

Similarly, the other six "Large Rail cities" are all older cities with high-density cores that have not been built elsewhere in the last century. While it is amazing that these regions have such low transit ridership compared with New York, any results for these six regions cannot be applied to newer regions such as Atlanta, Phoenix, and San Jose. These newer regions are just never going to look like Chicago or San Francisco. This is why I compared each region individually and didn't try to lump them together.

Litman: That is a key issue discussed in my paper, that is, whether new rail systems can achieve the land use impacts of older rail systems (see "Counter Arguments"). The evidence indicates it can, provided it is supported with appropriate transport and land use policies. The question is not whether Atlanta can become Chicago, but whether some Atlanta neighborhoods can become like *some Chicago neighborhoods, and whether rail projects that leverage such land use patterns provide more benefits than alternative transport improvements on that corridor.*

*Litman: O'Toole misrepresents his paper when he denies his analysis lumps cities with rail transit together. His report claims that, "*The twenty-three urban areas with rail transit collectively lost more than 33,000 transit commuters during the 1990s, while the twenty-five largest urban areas without rail transit collectively gained more than 27,000 transit commuters." *Not only is this an example of a broad statement comparing rail and non-rail cities, but he admitted to me more than a month ago that the numbers are incorrect (it should be a 14,097 loss in rail cities and a 1,388 gain in bus cities), yet he has not changed the wording of the reports posted on his website.*

2. PER CAPITA TRANSIT RIDERSHIP IS NOT AN INDICATOR OF LIVABILITY
O'Toole: Much of your report focuses on the allegedly high per capita transit ridership in rail regions. But why is this important? Even the fastest transit tends to be slower and (because it is not door-to-door) less convenient than the automobile. High levels of per capita ridership thus suggest lower levels of mobility. Perhaps this is because the city is so well designed that people don't need that mobility -- the Robert Cervero argument for accessibility rather than mobility. In fact, no urban area, with the possible exception of New York (really, only parts of New York) is designed to give people accessibility through transit. This means that high levels of per capita transit ridership probably mean lower levels of mobility, which in turn means higher housing costs, consumer costs, and other costs.

Litman: I agree that transit ridership is an objective, not a goal. The goal is to improve transport system performance and provide consumer benefits. Most urban mobility is a derived demand, to provide access to goods, services, and activities. Few people drive across town during rush hour just for the fun of it. Relative speed is just one aspect of access, some people prefer commuting by transit, particularly rail, because it is less stressful than driving, even if it takes more time. O'Toole evaluates transport system performance only in terms of mobility, not accessibility, and therefore ignores benefits that result when transit provides a catalyst for more accessible land use patterns. For more information see "Measuring Transportation: Traffic, Mobility and Accessibility", published last year in the ITE Journal (www.vtpi.org/measure.pdf), which discusses differences between mobility and accessibility.

I don't claim that every rail project significantly increases land use accessibility or that only rail transit investments can achieve these changes, but the study suggests that when such changes occur they can provide large benefits, including benefits to people who do not currently ride transit. Even relatively modest increases in transit mode split can cause relatively large per capita transport cost savings, congestion reductions and traffic death reductions. I think this occurs because the regional data hide larger local impacts, and shifts from automobile to transit tend to occur where it provides the greatest benefit (i.e., peak-period travel to major centers).

O'Toole is wrong to claim that transit oriented development and smart growth reduce housing affordability (See Nelson, et al., 2002; Carman, Bluestone and White, 2003). In some ways they reduce it (reduced per capita land supply) and in other ways they increase housing affordability (increased density allowances, more diverse housing options, reduced building setback requirements, reduced per capita parking costs, transportation costs, infrastructure cost savings *that reduce taxes and business costs, etc.). This study indicates that residents of cities with large, well-established rail systems spend significantly less on transportation than residents of other types of cities, providing significant additional cost savings to smart growth community residents. These values change little when New York is excluded.*

3. THE REPORT EMPHASIZES POINTS IN TIME WITHOUT SCRUTINIZING TRENDS
O'Toole: Most of the indicators in Great Rail Disasters were trends: typically 1990 to 2000. Most of the indicators in your report represent single points in time. Rail regions, for example, may have high per capita transit ridership, but if transit commuting is declining while it is increasing in bus regions, then that high ridership is pretty meaningless. Rail cities may have slightly lower per capita driving, but if per capita driving is increasing faster in those cities, it will not do them much good. Of your "large rail cities," Boston is the only one that is showing much transit growth. Of your "small rail cities," Portland and, to a lesser degree, San Diego are the only ones showing much transit growth. That is hardly indicative of rail's great success.

Litman: Simply tracking ridership trends indicates little about the effects of rail, since there is nothing to show how trends would differ without rail. Comparisons between cities with and without rail, or between rail cities and national trends, provide more useful information. I agree that low transit ridership is a reason for concern, but I don't think it proves that rail is necessarily a failure or a bad investment. Various cost-effective strategies described in my report can increase transit ridership and attract discretionary riders. The question therefore shifts from whether transit is good or bad, to how to optimize transit benefits. The concerns O'Toole raises can therefore justify MORE rather than LESS support for rail, provided they are cost effective.

4. RAIL COST EFFECTIVENESS IS GREATLY OVERESTIMATED
O'Toole: The report says that "rail transit is generally constructed in the densest part of a city where capacity expansion is most costly." It is equally true that rail transit is generally constructed in the slowest growing part of a city where capacity expansion is least needed. In any case, we have several examples of parallel rail and highway construction where the rail cost per passenger mile was far greater than the highway cost. Table 4 of your analysis compares user costs without mentioning the huge subsidies for rail transit. Through gas taxes, U.S. highways pay for themselves. Total subsidies to auto users are little more than 0.3¢ per passenger mile. Subsidies to the average transit rider are around 60¢ per passenger mile, and subsidies to rail riders are greater. Your analysis also compares operating costs, when in fact capital costs (when annualized using a standard amortization formula as required by the FTA) greatly outweigh operating costs for rail transit. That is like comparing the costs of housing but leaving out the costs of the walls and roof!

Litman: My goal is to create a comprehensive and accurate evaluation framework (see Litman, 2004a). Rail project budgets incorporate all associated costs. Buses require highways; and automobile travel requires vehicles, highways and parking facilities. It is inappropriate to compare rail capital costs with bus or highway costs without considering all vehicle, roadway and parking costs. I will incorporate capital costs in future analysis.

5. HOUSING AFFORDABILITY DISCUSSION WRONG
The report says that "rail transit projects and smart growth policies are generally implemented in rapidly growing cities where property values are rising due to increasing demand." That is not necessarily true. The fastest growing cities in the U.S. have no rail transit and little smart-growth

planning and their housing remains very affordable. It is only in cities such as San Jose and Portland, where planners have attempted to create a transit utopia by increasing population densities that housing prices have become dramatically unaffordable.

Litman: As described above, smart growth and transit-oriented development can increase overall housing and transportation affordability by reducing various costs.

6. SAFETY DISCUSSION USES WRONG MEASURE
O'Toole: I compared the safety of various forms of transport in terms of fatalities per passenger mile. You compare it in terms of fatalities per capita. If it is true that smaller cities have higher per capita driving, then they can have lower fatalities per passenger mile yet higher fatalities per capita. Which is the right measure? If you value mobility, as I do, then fatalities per passenger mile is the correct measure. Though regrettable, fatalities result from almost anything we do. The question is whether what we do is worth the risk. Is getting to work on time worth the tiny and declining risk of getting killed in traffic? Apparently it is because most people drive. If you don't value mobility, then fatalities per capita may be adequate. But then you have to ask what the people in your smaller rail and bus cities are getting for their mobility. I suspect they are getting lower housing prices and other consumer costs, a wider range of job opportunities, access to more recreation, etc.

Litman: As mentioned above, most urban mobility is a derived demand, not an end in itself. Few people want to live in a community that requires more driving, requires more vehicle cost and causes more traffic deaths if they can enjoy a similar level of accessibility without these problems. Large Rail cities tend to have higher average incomes, suggesting more rather than less access to employment options and higher levels of productivity.

7. THE COST OF SPRAWL IS EXAGGERATED
O'Toole: Your report says that I "favor automobile-oriented sprawl." Nothing could be further from the truth. I favor freedom of choice and I oppose government manipulation of people to get some predefined (and ineptly designed) goal.

Litman: Minimum parking requirements, single-use zoning, restrictions on density and multi-family housing, building setbacks, generous road standards and many other current policies support sprawl and automobile dependency, yet O'Toole only opposes regulations that support transit. Analysis by Shoup described earlier indicates that parking costs are 4.4 times higher than other development fees.

O'Toole: Cities without zoning (e.g. Houston) have demonstrated that, in the absence of regulation, people prefer to drive and to live in low-density, single-use developments. Cities with high degrees of regulation and restrictions on driving and low-density development (e.g., Paris, Amsterdam, and almost any other major European city) show that people still prefer to live in low densities and to drive, as driving is rapidly increasing and densities declining in almost all European cities.

Litman: The evidence is quite mixed, and it misrepresents the issue to claim that it proves any single thing. People are diverse and at least some prefer urban living. Many cities are now experiencing population growth. Residents of Houston now support development of alternative travel options, including HOV lanes, bus transit, and recently rail transit systems, because they *know from experience the problems that result from excessive dependency on automobiles, and therefore the benefits from a more diverse transportation system. This is not a question of urban versus suburban growth, rather, it is the nature of the growth that occurs since suburbs can be transit oriented.*[19] *Studies described in my paper indicate that many households are willing to pay a premium for New Urbanist housing and proximity to rail transit. Whether this market segment is a minority or a majority of consumers is irrelevant, as long as there is a sufficient demand (15-25% of urban households) it is large enough to support transit-oriented development.*

O'Toole: What is wrong with what you call "sprawl"? The Russians say that "Americans don't have real problems, so they make them up." Sprawl is one of those made-up problems. Pollution from auto driving is rapidly declining even though we drive more every year. Auto fatalities are also declining. Lower densities translate to lower housing and consumer costs, lower taxes, and less congestion. If people decide to move to higher densities, that is up to them. I only oppose subsidies and regulation designed to promote higher densities and discourage lower densities.

Litman: There is considerable literature on the costs of sprawl and benefits of smart growth (Litman, 2003b). Smart growth is supported by many mainstream organizations including the Institute of Transportation Engineers (ITE 2003), the International City/County Management Association (ICCMA 1998) and the American Governor's Association (Hirschhorn 2001), because of cost savings and other benefits. As a person of Russian descent I recommend against making general statements about what Russians say; two Russians, three opinions. None of O'Toole's claims are completely true. Some U.S. cities are experiencing increasing air pollution problems as vehicle mileage growth offsets vehicle-mile emission reductions. Per capita traffic fatalities are much higher in sprawled communities. Lower density housing often increases housing and transportation costs. As mentioned above, O'Toole indicates his bias by showing no concern about large subsidies and regulations favoring automobile dependency and sprawl.

9. LACK OF REFERENCES A VALID CRITICISM
O'Toole: You accurately point out that I failed to provide adequate references to some of my statements. I still stand behind those statements. In one case, I said that most rail cities are spending over half their transportation capital funds on transit. You can find the references at http://ti.org/vaupdate24.html. I will send you the list of EISs that I used to review rail costs and ridership soon.

Litman: That is helpful. However, the evidence presented misrepresents the issue. Rail transit projects show up in regional capital budgets, so they may appear proportionately large, but regional capital budgets are only a small portion of total transport expenditures. Analysis should consider total local, regional, and state capital and operating expenditures, plus expenditures by businesses on parking, and by consumers on vehicles and residential parking. Evaluation should reflect marginal analysis, not regional mode share. The major urban transport problems are traffic and parking congestion on major corridors, and inadequate mobility for non-drivers. Transit improvements can address these, and help achieve other objectives, including consumer cost savings, parking cost savings, reduced accidents and pollution emissions. As a result, transit investments that improve service quality and attract discretionary travelers are often the most cost effective transport improvement, even if they provide a small portion of total regional travel.

10. LAND USE IMPACTS
O'Toole: You claim that "increased density and clustering tends to reduce per capita automobile ownership and use." There is little if any evidence of that. It would be more accurate to say that "increased density and clustering tends to be correlated with lower per capita automobile ownership and use," and that is accurate only at the neighborhood level. All of the papers you cite focus on neighborhoods. The problem is self selection: people who want to use transit tend to live in transit-friendly neighborhoods. But increasing the density of neighborhoods occupied by people who want to drive is not going to significantly reduce their driving.

Litman: Many studies indicate that transit-oriented development can reduce per capita vehicle ownership and use ("Land Use Impacts on Transportation," VTPI, 2005). For example, a survey of Portland TOD residents found that 22% commute by transit, far higher than the 5% regional average, and 69% use public transit more often than in their previous community (Podobnik, 2002). This study shows that having numerous TODs in a city can significantly reduce regional per capita vehicle ownership and mileage rates.

In another exchange, O'Toole claims that "Portland voters turned down light rail funding three times" (implying that citizens of cities with rail transit systems don't support them). Although this claim may be technically correct, it distorts the history of Portland's votes:

- 1994 - Original regional vote to fund South/North line passed by 2/3 margin.
- February 1995 - Clark County voters defeated a measure to fund a Washington LRT line.
- August 1995 - Oregon Legislature approved state funding for the South/North project.
- November, 1996 - State Measure 32, which included $375 million for LRT and $375 million for roads, failed statewide 47/53% but passed in the Portland region.
- November, 1998 - Regional vote on Measure 26-74 to fund rail failed 48-52%, but passed in Multnomah County, site of the proposed line. All precincts along the proposed line approved it.
- Subsequently, a new proposal was developed which better addressed concerns of displaced homes and businesses, increase in property taxes, alignment, and costs. Community support moved Interstate MAX forward. One year later, communities that had voted against the project asked to have it reconsidered, resulting in the current plan to have two rail lines.

Although it is correct to say that votes to fund LRT in Portland failed three times, it is also correct to say that city of Portland voters supported all four light rail referenda, and in the TriMet service area, three of four passed. There is no indication that support for rail has declined since the LRT system was completed. By virtually any measure (increased transit ridership, increased downtown residential and commercial development, and support by residents and businesses to extend rail lines to additional areas), public support has increased.

After hurricane Katrina stuck in August 2005, O'Toole recommended improving emergency response by shifting public transit funds to subsidize automobile ownership for lower-income households and highway expansion to accommodate larger traffic volumes. He argues that high rates of transit use and low vehicle ownership rates in cities such as New Orleans cause poverty, while increased automobile ownership reduces poverty, rather than concluding that poverty my reduce vehicle ownership rates and lower-income people may tend to choose homes in areas well served by transit (see earlier discussion "Rail Transit Harms Poor People").

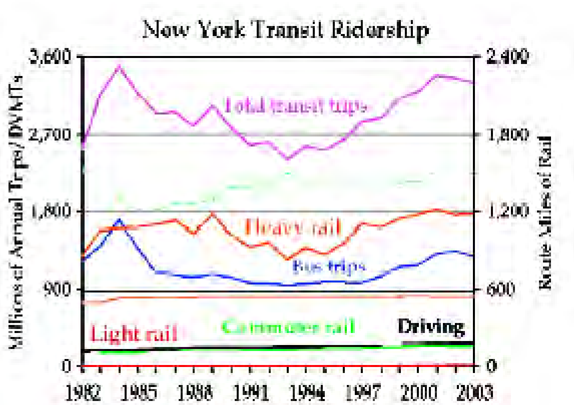
An alternative approach based on experience from both hurricanes Katrina and Rita suggests that the most equitable and efficient way of evacuating large numbers of people from an urban area is to give public transit vehicles (and perhaps other high occupancy vehicles) priority in traffic and fueling, in order to insure that the most vulnerable residents are well served and to efficiently manage available resources (Litman, 2005c). O'Toole criticizes this on the grounds that most evacuees would be unwilling to ride transit, and evacuation by automobile is overall most convenient and efficient.

Rail Disasters 2005: The Impact of Rail Transit on Transit Ridership

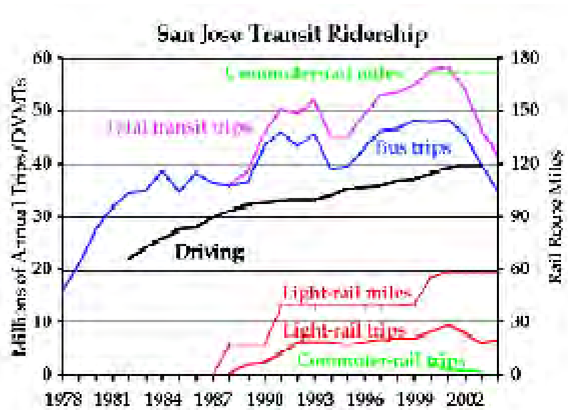
In 2005, Randal O'Toole published an update of *Great Rail Disasters*, which evaluates the effectiveness of rail transit in terms of its ability to increase regional public transit ridership. This narrow focus on ridership appears to be in response to *Rail Transit In America* (Litman, 2004a), and the previous edition of this report, which showed that much of O'Toole's previous criticism of rail transit was inaccurate and misdirected.[20]

O'Toole's 2005 report rates various U.S. cities on a scale from A to F based on their transit ridership trends during the last two decades. This rating system is arbitrary and biased. It assigns an "F" rating to most rail cities, including many where total transit ridership is growing. It ignores positive ridership trends during the last decade (starting in the early 1990s) in cities such as Cleveland, San Francisco, St. Louis, New York and Atlanta. It claims that transit ridership is flat or declining in San Jose, California, although it more than doubled between 1980 and 2000.

Figure 15 **O'Toole's Ridership Graphs**



O'Toole assigns New York an "F," claiming that transit ridership is flat. Yet ridership grew significantly between 1993 and 2001, and was projected to set new records until the 2001 terrorist attacks reduced regional travel activity.



O'Toole assigns San Jose's rail system an "F," claiming that long-term transit ridership is flat or declining. Yet ridership increased steadily from 1978 until 2000, when a recession reduced regional commute activity.

As in his 2004 report, O'Toole's ratings fail to account for rail system size. For example, it criticizes New Orleans and Seattle rail systems for failing to increase regional transit ridership although they are single lines that carry a small portion of regional transit trips. To evaluate rail impacts it is necessary to compare transit ridership between similar cities or corridors with and without rail, or rail cities with national averages. O'Toole ignores external factors that affect ridership. The eight "Old Rail" cities he criticizes for declining transit ridership are older industrial regions that lost population and employment during much of the analysis period (although many are now growing). The report ignores the effects of the 2001 terrorist attacks and resulting economic recession on commute travel, blaming all transit ridership declines on rail.

O'Toole compares rail regions with eight selected "Bus-Only" regions. The report does not explain why these particular cities were chosen, but they are all rapidly growing urban areas with high transit ridership growth. Many other "Bus-Only" regions lost transit ridership during this period. Matched pair analysis in Litman, 2004a indicates that regions with large rail transit systems have much higher per capita transit ridership than similar size cities with smaller rail or bus-only transit systems.

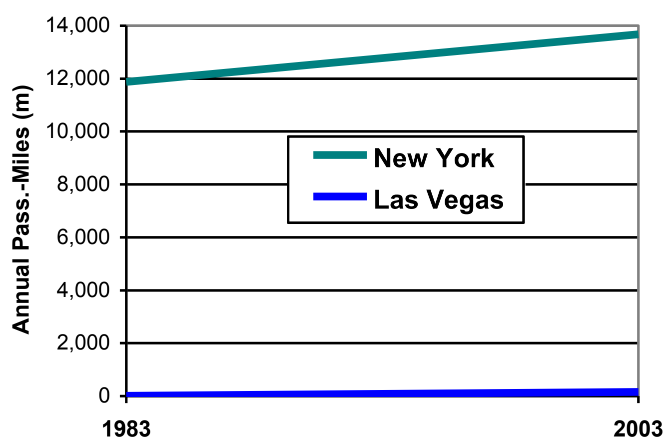
Table 8 **Change In Transit Ridership** (APTA Data)

	1983	2003	Total Change	Percent Change
1,000 Passenger-miles				
New York	11,879,309	13,673,085	1,793,776	15.1%
Las Vegas	15,665	158,205	142,540	910%
Population				
New York	7,071,639	8,008,278	936,639	13.2%
Las Vegas	164,674	478,434	313,760	191%
Passenger-miles Per Capita				
New York	1,680	1,707	28	1.6%
Las Vegas	95	331	236	248%

Although Las Vegas transit ridership grew significantly, this is because it started very low and grew to a moderate level. It is still small compared with per capita transit ridership in large cities such as New York.

For example, during the two-decade period transit ridership in Las Vegas (the selected city with the largest percentage ridership increase) grew ten fold, but population tripled, business boomed, and the city expanded to a size in which transit becomes increasingly important (Table 8). During the same period New York City transit ridership increased 15%, proportionately smaller but much larger than Las Vegas in absolute terms (Figure 16). Although Las Vegas annual ridership increased from 95 to 331 per capita passenger-miles, this is still small compared with New York's 1,707. At this growth rate it will take a century for Las Vegas residents to reach New York's current transit ridership.

Figure 16 **Total Transit Ridership Growth**



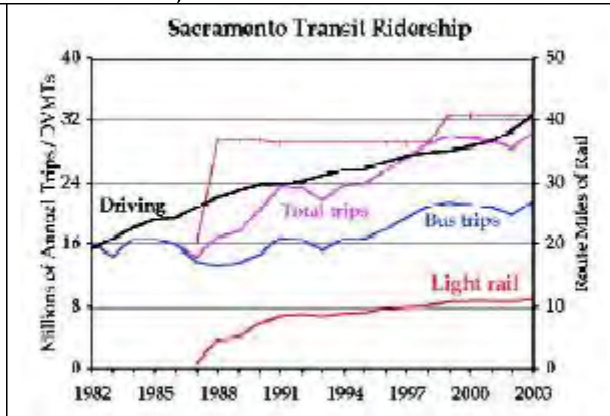
Transit ridership in Las Vegas (rated A) is small overall compared with New York (rated F).

O'Toole criticizes rail when bus ridership grows faster than rail ridership (on grounds that rail is ineffective), and when rail ridership grows faster than bus ridership (on grounds that bus ridership declined because resources were shifted to rail). He criticizes new rail transit lines for failing to immediately increase transit ridership, without taking into account the fact that it often takes many years for rail transit to achieve their full effects on land use and travel patterns, and therefore to achieve their full benefits.

O'Toole argues that buses are more cost-effective than rail at increasing transit ridership. As discussed earlier, this is not necessarily true, particularly if rail is implemented with supportive land use policies. Total transit ridership (rail and bus) tends to increase in cities that have implemented new rail systems, as illustrated in Figure 17, particularly if accompanied by supportive land use policies.

Figure 17 **Transit Ridership Increases** (O'Toole 2005)

Total transit ridership more than doubled in Portland between 1987, when their light rail system was established, and 2002.



Total transit ridership nearly doubled in Sacramento between 1987, when their light rail system was established, and 2002.

O'Toole ignores the ability of rail to help achieve strategic planning objectives, such as more compact and multi-modal development that reduces per capita automobile ownership and use, providing economic, social and environmental benefits (Litman, 2004a and 2008). It treats all transit passenger-miles equally, ignoring the fact that rail tends to operate in the densest corridors, where congestion, roadway and parking costs, and pollution impacts are highest, and so the benefits of reduced car travel are greatest.

O'Toole assumes that each region has a fixed transit budget, so money spent on rail transit reduces bus transit funding. This may be true under some circumstances in the short-term (such as the examples O'Toole describes), but in many situations rail funds would otherwise be spent on highways, and total per capita public transit funding tends to be higher in communities with rail transit systems (Litman, 2004a), indicating that rail and bus are complements rather than substitutes. This occurs because rail tends to generate public support for transit and provides a catalyst for more multi-modal travel, increasing use all types of transit. Over time, many regions with growing rail transit service also expand their bus services in response to growing demand.

O'Toole claims that transit is more dangerous than automobile travel, based on a comparison of fatality rates per passenger-mile and a few examples of new rail lines with high crash rates, such as Houston.[21] However, because rail transit tends to leverage overall reductions in per capita vehicle travel, per capita traffic fatalities and congestion costs tend to decline with increased rail transit service (Litman, 2004a and 2008).

O'Toole argues that rail transit systems are inequitable, because they tend to serve higher-income commuters at the expense of lower-income, transit-dependent bus riders. This is not always true. Many rail systems are heavily used by middle and lower-income travelers. This criticism assumes that money spent on rail would otherwise be spent on bus transit, but as discussed earlier, rail expenditures often substitute for highway expenditures. By creating more accessible, multi-modal communities, rail transit tends to reduce consumer transportation costs, and improve accessibility for non-drivers and low-income travelers (Litman, 2004a).

O'Toole argues that transit in general, and rail transit in particular, is subsidized more than automobile travel, based on comparisons of federal transit and highway expenditures. But this ignores additional subsidies and external costs of automobile travel, including local roadway expenditures, parking facility costs, congestion and accident risks imposed on other road users, and environmental impacts. It also ignores the fact that rail transit operates in the most congested urban conditions, where the costs of accommodating additional automobile trips are greatest. When all costs are considered, transit improvements are often more cost effective than highway capacity expansion (see discussion in Litman, 2008).

O'Toole argues that rail transit projects result from biased federal policies which reward inefficiency. But most new rail projects result from regional planning and referenda, reflecting citizen preferences for rail. Just as many consumers pay extra for a luxury automobile, many citizens are willing to vote for more costly but higher quality transit services.

The report argues that demand is equal for rail and bus transit, citing a study in one U.S. city which found that bus systems can attract as many passengers as rail systems that have comparable speed, frequency, comfort. But other studies indicate that rail tends to attract more discretionary riders, and therefore provides greater total benefits (Litman 2008).

In summary, O'Toole is wrong to claim that rail is ineffective at increasing transit ridership. His own data show that total transit ridership tends to increase as cities expanded their rail systems. His analysis justifies more, rather than less support for rail.

A Desire Named Streetcar

O'Toole (2006a) argues that federal transportation funding practices and political bias encourage local officials to invest in wasteful rail transit systems rather than more cost effective urban highways and bus systems. It is largely based on O'Toole's previous analysis (2004) which argued that rail transit is ineffective at attracting riders, has excessive costs, and few benefits. It assumes that automobile travel and sprawl will continue into the future, ignoring demographic and economic trends that support more compact and multi-modal development, such as aging population, increasing consumer demand for more accessible neighborhoods, and growing health and environmental concerns.

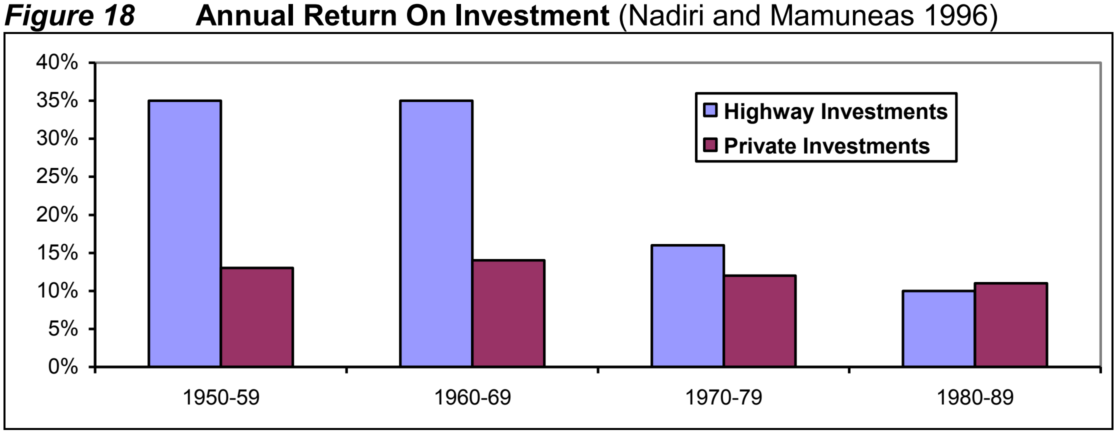
As described earlier, much of O'Toole's evidence that rail transit fails to attract riders is based on inaccurate and biased analysis, such as comparing rapidly-growing bus transit cities with rail cities that experienced little growth or negative population growth during the time period evaluated. He also ignores many benefits of rail transit, such as parking cost savings, consumer cost savings and positive land use impacts. Analysis by Litman (2004) and Lewis and Williams (1999) show that, when all impacts are considered, rail transit benefits can exceed their incremental costs, indicating that rail transit investments can be cost effective overall. O'Toole does not discuss these issues; he assumes without question that rail transit investments are wasteful and irrational. This basic premise is wrong, reflecting O'Tooles narrow analysis.

O'Toole claims that federal matching funds encourage wasteful rail transit investments. But the federal government provides much higher funding match for highways (usually 90%) than for urban transit systems (usually about 60%), requires less rigorous economic evaluation for highway projects than rail transit, and must compete for a much smaller portion of total transportation funding (Beimborn and Puentes, 2003). Because most transport funds are dedicated to highways, most highway projects are funded through existing revenues while transit projects often require voters to approve special new taxes. All of these create a much higher barrier for transit than highway projects.

O'Toole claims that "special interests" and politician's desire to have a rail station with their name leads to excessive rail transit investments. However, there are more special interests supporting highway projects (the "road lobby") and equal vanity gained by freeway and airport naming. For example, O'Toole claimed incorrectly that there is a rail transit station named after U.S. Transportation Secretary Norman Mineta in San Jose, California. There is none. Rather, there is a Norman Y. Mineta airport in San Jose.

O'Toole assumes that it would be more efficient and fair to invest in urban freeways than in rail transit. The economic return from highway expenditures has declined over time (Figure 18). Although highways showed high annual return on investment during the 1960s when the Interstate Highway System was developed, this has since declined significantly, and this decline is likely to continue since the most cost effective projects have been implemented. It therefore makes sense to invest less in roadways and more in public transit to maximize economic returns.

Figure 18 **Annual Return On Investment** (Nadiri and Mamuneas 1996)



Highway investments provided a high economic return when the Interstate system was first being developed, but these returns have declined and are now below the return on private investments, indicating that highway investments are not cost effective.

O'Toole criticizes flexible funding, which allows communities to choose the best transportation investments for their needs. This leads to more cost effective investments and is particularly important to accommodate changing transport needs.

O'Toole uses biased accounting to claim that transit receives more subsidy than automobile travel. He only includes general taxes used to fund highways, ignoring other subsidies to automobile travel such as free parking mandated by zoning codes. When these additional subsidies are considered, and taking into account the facts that about half of all transit subsidies are justified to provide basic mobility for non-drivers, that rail transit services are concentrated in major urban areas where road and parking costs are much higher than average, and that transit users tend to travel fewer annual miles than motorists, transit tends to receive about the same level of subsidy as automobile travel per passenger mile and far less per transit user. Significant transit subsidies are justified so that non-drivers and urban residents receive their fair share of transport funding.

O'Toole argues that the planning process has been hijacked by the "anti-highway lobby." But what he describes as a special interest group is really a mainstream movement to correct decades of transportation and land use planning practices biased in favor of automobile transport. Policies that O'Toole considers anti-highway, such as investments in walking, cycling and public transit, and smart growth development policies, have been widely embraced by the general public and professional organizations such as the Institute of Transportation Engineers, American Planning Association, the National Governors Association, and even many business organizations.

Light Rail Boon or Boondoggle

The article *Light Rail: Boon or Boondoggle* by Molly D. Castelazo and Thomas A. Garrett (2004) and a related report Garrett (2004) argue that light rail transit investments are inefficient compared with automobile investments. However, their arguments reflect a number of omissions, errors and misrepresentations (CMT 2004).

Castelazo and Garrett argue that transport decisions should be tested based on consumer willingness-to-pay, and claim that rail transit fails to meet this test because rider fares only cover a portion of total costs. However, they ignore the underpricing of urban automobile travel, including the costs of roads, parking, congestion, accidents and environmental damages not borne directly by users (Murphy and Delucchi 1998; FHWA 1997; Litman 2003a). This underpricing is particularly large under urban-peak conditions while transit subsidies tend to be lowest under such conditions due to higher load factors. As discussed earlier, transit subsidies may be partly justified on basic mobility, strategic land use planning objectives, and economic development grounds.

Castelazo and Garrett claim that light rail can only provide short-term congestion and pollution reduction benefits. This is untrue and indicates that they are unfamiliar with the issues. As described earlier, there is both theoretical and empirical evidence that high-quality rail transit can provide significant, long-term reductions in per capita congestion costs (Litman 2004a and 2008). It does this by attracting discretionary riders (people who have the option of driving for a particular trip), and providing a catalyst for more accessible land use patterns and more diverse transportation systems, which result in overall reductions in per capita vehicle travel.

This is not to suggest that the pricing reforms Castelazo and Garrett recommend are unjustified. Like most economists, I agree that more efficient transportation pricing can help solve many problems. With such a system, motorists would pay directly for using roads and parking facilities and for imposing external costs such as congestion, accident risk and pollution damages on other people. These price reforms increase the cost of driving (or put more positively, reward consumers for using efficient travel alternatives), particularly under urban-peak conditions, causing a significant portion of urban-peak automobile travel to shift to transit (Litman, 2002; VTPI, 2005).

Since rail transit experiences significant economies of scale, more optimal pricing should increase the cost-effectiveness of rail transit service. Conversely, efficient pricing of road use is likely to be more politically acceptable and effective if implemented in conjunction with transit service improvements. The better the travel alternatives available, the smaller the price needed to reduce vehicle use to an economically optimal level (i.e., the greater the elasticity of automobile travel to pricing), and so the smaller the cost imposed on both those who reduce their automobile travel and those who continue to drive. In other words, pricing and transit investments are complements, not substitutes.

Comparing Transit and Automobile Costs

Castelazo and Garrett argue that rail transit is *cost ineffective*, but they make a number of analytical errors discussed earlier in this report. They ignore many costs of automobile transportation and benefits of transit. They use *average* cost values that are not representative of the actual costs of accommodating additional urban vehicle traffic.

Castelazo and Garrett claim incorrectly that rail is more costly than bus transit. Under some circumstances rail has higher costs per passenger-mile, and under other circumstances rail has lower costs (Litman, 2004a). They claim that light rail operating costs average 54.4¢ per passenger-mile, reflecting national cost values, but this includes many new light rail systems that are still building ridership and so have relatively high costs per passenger-mile. In St. Louis light rail costs actually average 27¢ per passenger-mile, less than a third of the 82¢ per passenger-mile for bus transit services ("Bi-State Development Agency," *National Transit Database*, APTA, 2002). There are various reasons that buses have higher cost per passenger-mile: buses serve lower-density areas where ridership is low, and buses can carry far fewer passengers per driver. However, it is wrong to claim that light rail is more costly than either automobile or bus transport in the dense urban corridors where rail is actually implemented.

On congested urban corridors automobile travel often costs two or three times more than the 41.4¢ per passenger-mile Castelazo and Garrett assume. As described earlier, the cost of an automobile trip includes vehicle expenses, 10-50¢ per vehicle-mile for urban road capacity and congestion impacts, $5-15 per day for downtown parking (averaging 25-75¢ per vehicle-mile for a 20-mile round trip commute), plus 1-10¢ per vehicle-mile for pollution emissions (Murphy and Delucchi, 1998; FHWA, 1997; Litman, 2004a; "Costs of Driving," VTPI, 2005). This indicates that automobile travel on these corridors costs $0.77 to $1.76 per mile, far higher than light rail transit costs on the same corridor.

Transit services, particularly rail transit, tend to experience economies of scale. If some level of transit service is needed to provide basic mobility to non-drivers, the marginal cost of accommodating additional riders is often small, particularly if the system has additional peak-period capacity. For this reason, if rail transit really does have excessive costs per passenger-mile, the appropriate response may be to increase support for rail, through incentives such as road and parking pricing, commute trip reduction programs, fare subsidies, and other strategies that increase ridership and therefore reduce unit costs.

Castelazo and Garrett's research shows that rail transit projects can significantly increase property values. They find that average home values increase $140 for every 10 feet closer they are to a MetroLink station, beginning at 1,460 feet. A home located 100 feet from the station has a price premium of $19,029 compared with the same house located 1,460 feet away. Their analysis did not investigate property value impacts on commercial properties, which probably also increase with proximity to stations. This increase in property values, increased tax revenue, and the implied additional value to consumers, offsets a significant portion of MetroLink costs.

Providing Mobility for Non-drivers

Castelazo and Garrett argue that it would be cheaper to provide low-income motorists with a car than light rail transit service. This overlooks several important points.

First, transit is subsidized for several reasons besides providing mobility to lower-income travelers. This includes congestion reduction, road and parking facility cost savings, consumer cost savings, increased safety, pollution reduction and support for strategic development objectives. Only a small portion of transit subsidies could efficiently or equitably be shifted to any one of these objectives. If transit subsidies were eliminated and the money used to purchase cars for the 14% of transit riders Castelazo and Garrett consider low-income, other transport problems would increase, and the 86% of current transit riders who do not qualify would be worse off.

The table below evaluates the impacts of subsidizing cars for low-income drivers who would use rail transit, and therefore travel regularly on congested urban corridors. Although this benefits a certain group (low-income urban commuters on a particular corridor), it exacerbates other problems including congestion, road and parking facility costs, traffic accidents, energy consumption and pollution emissions.

Table 9 **Impacts of Subsidizing Commuter Cars**

Transit Objectives	Effect of Subsidizing Cars
Basic mobility for low income drivers.	Helps
Basic mobility for non-drivers.	No effect or harmful if it reduces total transit service.
Congestion reduction.	Harmful.
Road and parking facility cost savings.	Harmful.
Consumer cost savings.	Helps those who receive the subsidy.
Reduce traffic accidents.	Harmful.
Energy conservation	Harmful.
Emission reductions.	Harmful.
Economic development.	Harmful if it increases congestion and parking costs and expenditures on imported fuel and vehicles.

Second, many transit riders cannot or should not drive. They are too young, disabled, or prohibited from driving. Subsidizing cars instead of transit service would not solve their mobility problems and would tend to increase higher-risk driving. It is easier to reduce driving by high-risk motorists in communities with good transit systems, for example, by delaying teenage vehicle ownership, revoking driving privileges for dangerous drivers, and reducing vehicle use by elderly residents, which helps explain the much lower per capita traffic fatality rates in areas with good transit service.

Third, substituting car ownership for transit service is probably far more expensive than they claim. Eliminating scheduled transit service would force riders who cannot drive to use demand-response or taxi services, which have far higher costs.

Fourth, increased vehicle traffic on busy urban corridors would significantly increase traffic congestion, road and parking costs, accidents, pollution and other external costs. Castelazo and Garrett misinterpret and underestimate congestion costs. In footnote 3 they calculate that giving 7,700 vehicles to current rail users would increase regional vehicle ownership by 0.5%, which they assume would only increase congestion by 0.5%. But rail users are commuting on the city's most congested corridors, so congestion impacts will be proportionately large. Congestion is a non-linear function; once a roadway reaches capacity even a small volume increase adds significant delays. For example, on an uncongested road, 100 additional vehicles per hour may cause little delay, but adding the same number of vehicles on a road at 90% capacity can increase delays by 20% or more.

Shifting 7,700 current St. Louis rail transit riders to automobile commuting is likely to increase regional traffic congestion costs by far more than 0.5%. The Texas Transportation Institute calculates that St. Louis traffic congestion costs totaled $738 million in 2001. If 7,700 additional downtown automobile commuters would increase regional traffic congestion costs 2.5% to 5.0%, this represents $18 to $37 million in additional annual congestion costs.

Fifth, there are substantial practical problems to subsidizing cars or carsharing instead of transit services. Castelazo and Garrett apparently assume that the 7,700 rail transit riders they identify as being unable to afford a car are a distinct, identifiable group. In fact, they consist of a much larger group, many of whom use transit part-time, or who sometimes do not own an automobile. For example, non-car owning riders may consist of 3,000 daily transit users, 4,000 who use it half-time, 10,000 who use it an average of once a week, and 700 out of town visitors. Similarly, some people who do not own a vehicle this month will next month, and vise versa. As a result, rather than giving 7,700 households a car, it would be necessary to offer a much larger number of households a part-time car, with provisions that account for constant changes in vehicle ownership and travel status, and for the increased travel that occurs when non-drivers gain access to an automobile. Like any subsidy program, it would face substantial administrative costs and require complex rules to determine who receives a subsidy, and how much they receive, in a way that seems fair and effective at achieving its objectives. It would create perverse incentives, rewarding poverty and automobile dependency.

Finally, as described earlier, rail transit can provide a catalyst for mixed-use, walkable urban villages and residential neighborhoods where it is possible to live and participate in normal activities without needing a car, which is particularly beneficial to non-drivers.

Although it is desirable to provide affordable mobility to lower-income people (“Affordability,” VTPI 2005), it is important to avoid oversimplifying this issue or ignoring the important role transit service play in meeting this need.

Urban Rail: Uses and Misuses

*Wendell Cox is a frequent rail transit critic. For example, he criticizes rail in a policy statement titled "*Urban Rail: Uses and Misuses" (Cox, 2000)*. Below are his claims and my responses.*

Virtually no traffic congestion reduction has occurred as a result of new urban rail systems.

- While city-wide congestion measured as roadway level of service or travel time index does not usually decline after light-rail systems are built, this is not surprising because light rail is developed where travel demand is growing, and light rail represents a small portion of total regional travel. Rail transit clearly does reduce congestion compared with what would have occurred otherwise, and when evaluated at the corridor level. As described earlier in this report, and in Litman (2004a and 2008):
- Large cities with rail transit systems have about half the per capita traffic congestion costs as similar size cities that lack rail transit. The more rail transit service provided, the more rail ridership and the more congestion is reduced.
- Traffic congestion tends to decline on a road if there is fast and comfortable rail transit service on the same corridor, since some travelers will shift to transit when it is faster than driving, reducing the point of congestion equilibrium.
- Residents of urban neighborhoods served by new or expanding rail transit systems tend to reduce their vehicle ownership and increase their use of transit, reducing per capita automobile trips (see box).
- On major urban corridors, rail transit improvements are often more cost effective than roadway capacity expansion, when all costs are considered.
- Traffic congestion growth rates declined after light rail systems were built in several cities. Garrett (2004) found that traffic congestion growth rates declined somewhat in some U.S. cities after light rail service began. As previously mentioned, in Baltimore the congestion index increased an average of 2.8% annually before light rail, but only 1.5% annually after. In Sacramento the index grew 4.5% annually before light rail, but only 2.2% after. In St. Louis the index grew an average of 0.89% before light rail, and 0.86% after. In Dallas, the growth rate did not change.

Transit Improvements Help Reduce Vehicle Ownership and Use (www.translink.bc.ca)
In 2004 the city of Vancouver recorded a decline in the number of automobiles registered in the city, and a reduction in downtown automobile trips, reversing a growth trend between 1994 and 2003. Small decreases were also recorded in some nearby suburbs, and others saw a reduction in the growth rate. Experts conclude that this results from increased transit services and a growing preference for urban lifestyle. "There are some fundamental changes going on," says David Baxter of the research firm Urban Futures. "It's increasingly possible to live in Vancouver without a motor vehicle."

Commuters are increasingly using alternative modes. Transit ridership rose by 9.5% in the first half of this year compared to the same period last year, and was 24.6% higher than 2002. Bus trips increased by 11.1%, and rail trips increased by 5.4%. A customer survey found that that 42% of riders on the SkyTrain, 49% on the West Coast Express, 35% on the 99B bus route and 25% on the 98B route switched from commuting by car. "The numbers show that demand for public transit continues to grow in response to the significant expansion of services."

Virtually any public benefit that has been achieved through urban rail could have been achieved for considerably less by other strategies.
Rail transit provides unique benefits. Cities with large rail transit systems have substantially higher per capita transit ridership, lower per capita congestion delays, lower per capita traffic fatalities, lower consumer transportation costs, lower transit operating costs, higher transit service cost recovery, and other positive attributes, compared with otherwise similar cities (Litman, 2004a). This occurs because rail tends to attract far more discretionary riders than bus, does not require the ability to drive like a private automobile, avoids congestion delays if grade separated, and it can have a leverage effect on land use which greatly expands total benefits.

Where the automobile has become the dominant form of transport, and where urban areas have become decentralized and highly suburbanized, there are simply not a sufficient number of people going to the same place at the same time to justify urban rail. As a result, it is typically less expensive to provide a new car for each new rider than to build an urban rail system.
Many cities are redeveloping, with increased population and business activity. At the same time, many suburbs are becoming more urbanized. If a travel corridor has enough travel demand to create significant congestion, there is often enough demand to justify some form of grade-separated transit.

Claims that it is cheaper to provide a new car rather than build an urban rail system usually overlook some significant costs, including the costs of vehicles, roads and parking facilities at destinations (as discussed earlier and in Litman, 2004d). Increased car ownership exacerbates other transportation problems, including traffic congestion, road and parking facility costs, traffic accidents and pollution emissions, and does not address the mobility needs of non-drivers. Expanding urban road and parking capacity is costly, and provides only modest congestion reduction due to latent demand.

Cox (2004) also argues that it would be cheaper to subsidize carsharing (vehicle rental services designed to substitute for private vehicle ownership), which he assumes could be accommodated by doubling demand-response funding, but since demand response services only provide 1.4% of total transit passenger-miles, doubling its funding could not compensate for reducing the other 98.6% of services. Current carshare services are relatively cheap because they are located in a few suitable urban areas. To provide carsharing in all areas currently served by fixed-route transit, with enough vehicles to accommodate all peak-period users, could increase unit costs. People tend to significantly increase their travel when they shift from transit to having an automobile, so even if per-mile costs decline, per-user costs would likely increase.

Cox (2003) argues that virtually all current trends favor automobile transportation over transit, that extreme densities are needed for rail transit to be effective, that an excessive portion of urban transportation funding is devoted to public transit, and that investments in highway capacity expansion are a more cost effective way to improve urban transportation. His analysis makes many of the errors discussed earlier in this paper.

- Many current demographic and geographic trends actually favor increased use of alternative modes, including an aging population, increased urbanization (many cities are experiencing population growth, and many suburbs are developing into cities), physical constraints to expansion in many growing urban areas (for example, Las Vegas is limited by water supply and Seattle is limited by geography), and higher future oil prices.

- The analysis and arguments are based on the assumption that vehicle traffic congestion is the only significant transportation problem facing cities, and therefore reducing roadway congestion is the only planning objective. Other transportation problems, such as mobility for non-drivers, parking problems, consumer and government affordability, traffic safety, urban environmental quality, energy conservation, and pollution emission reductions are unimportant and not incorporated in his performance evaluation.
- He significantly underestimates the full costs of increasing urban traffic capacity enough to reduce congestion. Cox dismisses the effects of generated traffic, although it is accepted by nearly all serious traffic modelers (see Litman, 2001), including the fact that it reduces the congestion reduction benefits of increasing roadway capacity and the additional impacts of the added vehicle traffic.
- Estimates of the portion of total transportation expenditures devoted to transit are not clearly referenced, and even if accurate are greatly exaggerated since they do not account for all local, state, and federal expenditures, or indirect costs, such as expenditures on parking facilities.
- Cox dismisses the potential role of public transit, on the grounds that transit only carries 1% of total projected traffic growth. But on congested urban corridors transit can carry a much larger portion of traffic, and make a much larger contribution toward congestion reduction. If a travel corridor has enough travel demand to create significant congestion, there is often enough demand to justify some form of grade-separated transit.
- Cox assumes the only way to increase transit ridership and transit system performance is to greatly increase regional land use densities. But there are many other options which are justified on economic efficiency grounds, including road and parking pricing reforms, transit oriented development (which clusters development around transit stations, but does not necessarily increase regional densities), transit priority strategies, commute trip reduction programs, transit service improvements and targeted transit fare discounts.
- Cox's analysis includes various unexplained assumptions and data sources, such as the claim that urban traffic congestion could be significantly reduced with a $39 billion highway program, or that this provides a 6:1 benefit/cost ratio. Many of his arguments, such as the claims that highway widening causes no induced vehicle travel, or that smart growth and increased transportation system diversity are politically unacceptable, are based on nothing more than selective anecdotal evidence. In fact, there is plenty of evidence showing the opposite (Litman, 2001; Litman, 2003a).

Commuter Rail's False Promise

Tom Keane (2006) argues that rail transit is a poor investment because it fails to increase development or transit ridership in modern cities. Citing a study by Beaton (2006), he states, "One would think, for instance, that new commuter-rail stations might encourage development nearby. It turns out they don't. Areas around train stations are only modestly more developed than anywhere else. One would also think that new stations might encourage more use of public transit. That is also untrue. The number of people using transit to get to work is largely unchanged by the addition of new stations." He explains this as proof of declining demand for commuter rail since automobile transportation became dominant in the 1960s.

This misrepresents the analysis. In fact, Beaton found that in the Boston region, rail transit zones (areas within a 10-minute drive of commuter rail stations) had higher land use density, lower commercial property vacancy rates, and higher transit ridership than other areas. Regional transit ridership declined during the 1970s and 80s (it has rebounded since 1990), but declined significantly less in rail zones, indicating that TOD increases ridership compared with what would otherwise occur. In 2000, transit mode split averaged 11-21% for rail zone residents, compared with 8% for the region overall. Areas where commuter rail stations closed during the 1970s retained relatively high transit ridership rates, indicating that the compact, mixed land use patterns that developed near these stations has a lasting legacy.

Although Beaton found that land use density did not increase near stations built between 1970 and 1990, they did increase near stations build after 1990. This can be explained by the fact that the value of smart growth (more compact, mixed, multi-modal land use development) only became widely recognized in the 1990s, and much of the research and literature on transit oriented development is even more recent.

Similarly, detailed analysis by Badoe and Miller (2000) conclude that transit service can facilitate land use development patterns, but is only one of many factors and will not cause significant land use or travel behavior change by itself. They found that if an area is ready for development, improved transit service (such as a rail station) can provide a catalyst for higher density development and increase property values, but it will not by itself stop urban decline or change the character of a neighborhood.

Keane is wrong to conclude that rail transit investments cannot affect travel or land use. Virtually all research indicates that rail transit improvements can increase ridership and create more compact, mixed, multi-modal communities, provided they are implemented with supportive transportation and land use policies. When this is done the research shows that rail transit zones have significantly higher property values and transit ridership than would otherwise occur (Cervero, et al, 2004; Litman, 2005).

The Social Desirability Of Urban Rail Transit Systems

A study by Clifford Winston and Vikram Maheshri (2006) titled *The Social Desirability Of Urban Rail Transit Systems* estimates the social benefits of 25 U.S. rail transit systems based on consumer demand (users' willingness to pay for rail transit services) and congestion reduction benefits. They conclude that only one system (BART) is cost effective. They argue that rail transit investments result from misguided political support rather than rational analysis.

But this study applies questionable statistical analysis (Warner 2007; Goddard 2009), overlooks many rail transit benefits (reduced road and parking costs, traffic risk and pollution emissions), and ignores positive land use impacts such as efficiencies of agglomeration and rail transit's ability to create more compact, multi-modal land use development that reduces per capita vehicle ownership and use. By ignoring these effects it assumes that one passenger-mile of rail substitutes for one vehicle-mile of driving, and so undervalues benefits associated with reductions in per capita vehicle travel. The evidence provided in the paper to justify these exclusions is one-sided and anecdotal.

Winston and Maheshri argue that rail transit plays a declining role in the U.S. transport system, but much of their evidence is outdated, reflecting trends such as housing and employment dispersion that are now reversing in major North American cities. They ignore projections that an increasing portion of U.S. households may value living in transit oriented neighborhoods (Reconnecting America 2004). They argue that rail transit's role is declining because it only serves old central business districts, which they estimate contain only 10% of regional employment. But this misrepresents the role of rail transit, which connects urban and suburban activity centers (business districts, malls, campuses and airports) and helps attract more businesses to central locations. As a result, cities with major urban rail systems tend to have a major portion of jobs, particularly higher-order jobs that involve longer commutes, located near rail transit stations.

Winston and Maheshri argue that rail transit is inefficiently subsidized, but ignore automobile transportation subsidies such as roadway costs not borne through user fees, subsidized parking, external congestion, accident and pollution emissions. Although they analyze how various transit pricing and operational changes could affect rail service cost efficiency, they fail to test the effects of efficiency-justified market reforms, such as congestion pricing, parking pricing, parking cash-out, and pay-as-you-drive vehicle insurance, which could increase transit ridership and therefore rail transit benefits. In other words, existing market distortions that favor automobile over transit travel (subsidized parking, unpriced road space, fixed vehicle insurance) reduce transit demand below what is optimal, thereby reducing transit efficiencies and measured benefits.

Parry and Small's 2007 study, which concluded that public transit subsidies are economically efficient, includes analysis which explains why their results are so different from Winston and Maheshri. They point out that Winston and Maheshri ignore scale economies, assume very high transit operating costs, and use a relatively high transit fare price elasticity value. More reasonable assumption indicate net benefits from rail service.

Careless Omissions Or Intentional Bias?

Good research provides comprehensive information so readers can make a fair judgment about an issue. Good research follows principles and practices to insure that information is accurate and balanced, as listed below. Critics generally fail to follow these practices.

Good Research Practices (Litman 2004c)

- Attempts to fairly present all perspectives of an issue.
- Provides context information by summarizing issues and by referencing relevant documents.
- Carefully defines research questions which link specific research to broader issues.
- Provides accurate data and appropriate analysis in a format that can be accessed and replicated by others.
- Discusses critical assumptions made in the analysis such as why a particular data set or analysis method is used.
- Presents results in ways that highlight critical findings.
- Discusses conclusions and their implications. Discusses alternative explanations and interpretations, including those with which the researcher disagrees.
- Describes analysis limitations and cautions. Does not exaggerate implications.
- Is respectful to people with other perspectives.
- Provides adequate references.
- Indicates funding sources, particularly any that may benefit from research results.

These critics fail to discuss key decisions concerning the selection of data sources and analysis methods. For example, Cox (2010) uses the *ACCRA Cost of Living Index* rather than the Bureau of Labor Statistics *Consumer Expenditure Survey Data* without disclosing that the ACCRA Index reflects the highest income quintile and therefore is not representative of normal households and is inappropriate for evaluating affordability impacts. O'Toole does not explain why he compares transit energy consumption rates with those of passenger cars rather than the higher weighted fleet average rate. Similarly, Castelazo and Garrett do not discuss why they use national cost values (54.4¢ per passenger-mile) rather than local values (27¢ per passenger-mile) when assessing rail costs transit. Cox makes general statements without evidence, many of which are contradicted by current research.

In virtually every situation, these critics choose the data and analysis option that presents rail transit most negatively. It is possible that they have valid reasons for making these choices, but they do not describe them as required for good research practices. This suggests that the various omissions and distortions in these reports are intentional, designed to present rail transit in a negative light, rather than to provide fair and comprehensive information on benefits and costs.

Points of Agreement

Transit critics raise some important issues. I agree that the relatively low portion of total trips made by public transit, and the declining transit mode share, are concerns. However, I believe that this reflects the need to correct existing market distortions that favor automobile travel over transit. Simple market reforms that are justified on both efficiency and equity grounds, such as parking cash-out, distance-based vehicle registration and insurance pricing, and least-cost planning, can substantially increase transit ridership by creating a more level playing field ("Transit Encouragement," VTPI, 2003). Various cost effective strategies for improving transit service and increasing ridership are described in the next section.

It is also reasonable to argue that rail transit investments should not be made at the expense of bus service. In many situations, incremental bus service improvements may provide faster, more equitable and greater total benefits than rail transit improvements. However, bus systems do not seem to have the positive effect that rail has on land use accessibility, have less ability to attract discretionary riders, and have some disadvantages compared with rail on high demand corridors.

The relatively high traffic accident rate of rail transit is also a concern, and efforts should be made to reduce this through education and traffic management. Recent experience in Salt Lake City and Houston indicate that crash rates are high when light-rail systems are first introduced in a city, but decline as drivers become familiar with new traffic operations. However, these high crash rates per passenger-mile are offset many times over by reductions in per-capita crash fatalities, and are probably further offset by additional health benefits from reductions in urban air pollution exposure, and increased walking by commuters who shift from driving to transit.

My criticism of omissions and errors by critics must be tempered by the fact that the data needed for some analyses are unavailable. In particular, it is difficult to obtain accurate data on the marginal cost of expanding roadway, bus and rail systems, and so it is often necessary to use average-cost data. But a rough estimate of marginal costs is more accurate than precise average-cost data, and when average values are used, it is important to identify the direction of error; marginal roadway and parking facility capacity expansion costs tend to be higher in dense urban centers and that transit demand is particularly high in such corridors, which can result in low unit costs.

I also am concerned about housing affordability and the impacts of planning decisions on low-income households. However, research by myself and others indicates that more accessible community design, more diverse transportation systems, and more flexible residential development standards are the best ways to improve overall affordability and increase economic opportunity, because they can reduce both housing and transport costs, and provide other benefits to lower-income people, such as improved accessibility for non-drivers ("Location Efficiency Development," VTPI, 2003).

Conclusions

Public transit can provide numerous benefits to users and society. Many of these benefits depend on the degree that transit attracts discretionary passengers and therefore reduces automobile travel and associated costs such as traffic and parking congestion, accidents and pollution emissions. This requires high quality rail or bus rapid transit (BRT) services that are relatively convenient, comfortable and fast (with grade separated tracks or lanes), plus attractive stations that provide a catalyst for transit-oriented development.

Current demographic and economic trends (aging population, rising fuel prices, urbanization, increasing health and environmental concerns, changing consumer preferences, etc.) are increasing consumer demand for alternative modes and therefore the potential benefits of high quality transit. To prepare for these future demands and achieve these benefits many urban regions are investing in rail transit systems. Considering all impacts and benefits, these are often cost effective investments.

Rail transit investments are sometimes criticized as inefficient or inequitable. Some of this criticism is constructive, identifying possible ways to improve rail project evaluation, but some criticisms are inaccurate and unfair, based on incomplete analysis. This report evaluates these criticisms and describes appropriate responses to inaccurate claims. Table 10 summarizes common criticisms and appropriate responses.

Transit project economic analysis can be confusing because different types of transit services provide different types of benefits. *Mobility benefits* require special equipment such as wheelchair lifts and service at times and places with low demand, which may seem inefficient due to high operating costs per passenger-mile. *Efficiency benefits* require premium service designed to attract discretionary travelers on major urban corridors which may seem inequitable due to relatively high costs and amenities that benefit wealthier users. As a result, some transit services may seem inefficient and others may seem inequitable, but each can be justified to achieve their objectives and benefits.

Critics are wrong when they claim that rail fails to reduce traffic congestion and emissions. High quality transit reduces congestion on parallel highways by attracting some peak-period who would otherwise drive. By leveraging vehicle travel reductions, high quality transit and transit-oriented development can provide significant consumer savings, safety benefits, energy savings and emission reductions. Critics are either unfamiliar with current research or intentionally misrepresent these issues.

Critics often use incomplete comparisons between rail, bus and automobile transport. They understate total transit benefits and the full costs of automobile travel. Critics claim that rail transit is costly and subsidized, but its operating costs are lower, cost recovery higher, and total benefits larger than bus transit. Rail often has far lower total costs (including roads, parking and vehicles) than accommodating additional urban automobile travel. Transit subsidies are often justified for equity sake, to achieve scale economies, and to help achieve a strategic planning objective, factors critics generally ignore. Some rail criticisms are actually justifications for higher quality service and more supportive land use polices to increase ridership and benefits.

Table 10 **Common Criticisms and Responses**

Critics' Claims	The Truth	Appropriate Responses
Transit is outdated – demand is declining	Transit ridership declined in North American during the last half of the Twentieth Century but is now growing. Current demographic and economic trends are increasing future transit demand.	Examine how current demographic and economic trends will increase future travel demands. Identify latent demand for high quality transit. Show how transit supports strategic planning objectives.
Transit fails to attract new riders and reduce automobile travel	High quality transit usually significantly increases ridership, much of which substitutes for automobile travel. This indicates significant latent demand.	Examine ridership on high quality transit systems in similar communities. Survey travelers concerning the types of transit systems they want and would use.
Transit investments are not cost effective	Although rail transit may not be justified based on any single benefit, it is often cost effective considering all impacts.	Identify all major benefits. Emphasize that these benefits are widely distributed, including benefits to non-users.
Transit is ineffective at achieving objectives such as congestion and emission reductions	Critics often use incomplete or outdated analysis. Current research indicates that high quality transit can provide significant congestion and emission reductions.	Provide the best current information based on actual projects rather than average values. Evaluate integrated programs.
Transit is slow and inefficient	Rail and BRT are often time competitive with driving under urban-peak conditions. If high quality service is available travelers can choose transit when most efficient overall.	Identify how transit improvements can increase travel speeds and efficiency. Compare transit with automobile travel times under urban-peak conditions.
Transit is subsidized, automobile travel is not	Transit services are subsidized directly, automobile travel is subsidized indirectly by road and parking costs not borne directly by users, and fuel and pollution externalities.	Identify the full costs and subsidies of urban automobile travel. Compare subsidies per capita, not just per passenger-mile.
Rail transit harms poor people by reducing funding for basic transit services	Rail projects generally receive new transit funding. Basic bus service tends to increase as rail systems expand. Poor people do use and benefit from rail transit services.	Indicate how much of rail funding is "new." Highlight benefits to poor people from high quality transit services and more transit-oriented development.
Bus transit is cheaper than rail	Rail often has higher capital but lower operating costs than buses, and by attracting more riders has lower costs per passenger-mile and greater total benefits. True bus rapid transit (BRT) incurs many of the same costs as rail, for grade separation, high quality vehicles and attractive stations.	Compare long-run costs and benefits, including the additional benefits from high quality services that attract discretionary travelers.

Many common criticisms misrepresent key issues and can be challenged.

Rail transit investments can be an appropriate way to create more efficient and diverse urban transport systems that better respond to consumer demands and future economic conditions. Although few motorists want to give up driving completely, many would prefer to drive less and rely more on public transit, provided high quality service is available. Rail transit is not justified everywhere, but it is often a cost effective way to improve urban transport systems, considering all impacts and objectives.

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Endnotes

[1] Per capita congestion delay is a better indicator of transit congestion impacts because it accounts for the congestion avoided by travelers who shift from driving to grade separated modes, and by land use patterns that reduce travel distances. Residents of dense, transit-oriented cities may experience relatively intense congestion when they do drive, but they drive fewer annual miles and so experience less congestion delay per capita. Indicators such as roadway level-of-service and congestion delay indices overlook these factors and so underestimate the congestion reduction benefits of grade-separated transit.

[2] Subsequent investigations indicate that the economic benefits are probably even greater because the IMPLAN model includes inaccuracies which exaggerate the jobs and economic activity generated by fuel and automobile expenditures. For example, it assigns gas station jobs to fuel sales, although such businesses make most of their profits from other products such as food, cigarettes and lottery tickets. The model also uses outdated values of the portion of new vehicle input value that is domestic, and does not account for the productivity losses caused by trade deficit resulting from vehicle and petroleum imports.

[3] Transit funding has remained at about 20% of federal transportation expenditures for more than two decades and funding for *enhancements*, which includes non-motorized facilities and various other projects, receives less than 5%. For information see the "Finance" section of the *FHWA Highway Statistics* reports at www.fhwa.dot.gov/policy/ohpi/hss/index.cfm.

[4] That transportation costs are lower in rail transit cities on average, but higher for wealthier households, indicates that these savings are skewed to lower income households, indicating that they are progressive with respect to income and are particularly effective at increasing affordability.

[5] For more discussion of the value travelers place on increased transit convenience and comfort see Todd Litman (2008a), "Valuing Transit Service Quality Improvements," *Journal of Public Transportation*, Vol. 11, No. 2, Spring 2008, pp. 43-64; at www.nctr.usf.edu/jpt/pdf/JPT11-2Litman.pdf; a more complete version is at www.vtpi.org/traveltime.pdf.

[6] In fact, the report referenced in footnote 42 (Rémy Prud'homme and Chang-Woon Lee, "Size, Sprawl, Speed and the Efficiency of Cities," Observatoire de l'Économic et des Institutions Locals, November 1998, http://www.rprudhomme.com/resources/Prud$27homme+$26+Lee+1999.pdf) concludes that Paris is more economically productive than London because it has invested more in public transit and has less sprawl, which increases employment access, the opposite of what Cox claims in his paper.

[7] Cox is correct that the traffic fatally data was mislabeled, the correct source is the National Highway Traffic Safety Administration as published in Ewing, Pendall and Chen (2002), not FTA 2001.

[8] I am a strong supporter of bus transit improvements, particularly BRT. I wrote several sections of the *Bus Rapid Transit Planning Guide* (www.itdp.org/index.php/microsite/brt_planning_guide) and am particularly proud of my contribution to the BRT systems recently established in South Africa, as discussed in my blogs, Rea Vaya ("We are Moving") In South Africa and And The Winner Is….

[9] Subsequent rail critics such as Balaker (2004) rely heavily on O'Toole, citing him and his sources, and also fail to use best current practices in evaluating transit benefits or provide information that does not support his conclusions.

[10] For information on transit evaluation best practices see Cambridge Systematics, 1998; FTA, 1998: Lewis and Williams, 1999; Phillips, Karachepone and Landis, 2001; HLB, 2002; Kittleson & Associates, 2003; MKI, 2003 and Litman, 2008.

[11] Randal O'Toole, the author of *Great Rail Disasters* was kind enough to send me his analysis spreadsheet for review. I found several substantial errors and reported them to him at the end of February 2004. He recalculated the data and adjusted the results downward, from a 33,000 commuter loss in rail cities and a

27,000 gain in bus cities, to a 14,097 loss in rail cities and a 1,388 gain in bus cities. Other values in the report will also need correction. Mr. O'Toole promised to correct these errors March 2004, but the reports posted on the Center for The American Dream website in 2005 still contain the false data.

[12] Winston and Langer (2004) found a strong positive relationship between rail transit system mileage and transit ridership.

[13] For example, a $376 million project started in 2004 to add carpool lanes along six miles of Interstate 215 in Southern California averages about $31 million per land-mile, and Boston's Big Dig project cost hundreds of millions of dollars per added lane-mile. Of course, these are particularly costly projects because they occur in major cities, exactly where rail transit projects are implemented.

[14] Analysis of delay reduction benefits to people who shift from driving to high quality public transit is difficult, in part because some of the benefit is results from reduced stress and greater comfort to transit passengers compared with motorists driving in congested conditions, rather than time savings measured by a clock. See discussion in the "Travel Time Costs" chapter of Litman (2003a) and Litman (2008).

[15] Measuring risk per passenger-mile assumes that increased low-risk travel increases safety. For example, by this measurement, an increase in vehicle travel on grade-separated highways (which have a low crash rate per passenger-mile) increases overall traffic safety. Measuring crashes per capita allows traffic risk to be compared with other health risks.

[16] Flyvbjerg, Holm and Buhl (2002) conclude that transportation project cost projection accuracy did not measurably improve between 1990 and 1998, but Figure 3 of their report actually suggests that between 1985 and 1998 cost accuracy improved significantly. FTA (2007) also found that accuracy increased substantially over time.

[17] In mid-March, 2004 Randal O'Toole agreed to my request to provide more specific information on his analysis of transit project cost overruns and ridership shortfalls for review, but despite repeated requests, as of Sept. 2005 he provided nothing. Without this information it is not possible to verify his claims.

[18] For more discussion of these issues see Todd Litman, *Evaluating Research Quality: Guidelines for Scholarship*, Victoria Transport Policy Institute (www.vtpi.org), 2004.

[19] Many suburban communities are developing into towns and cities. A good example is Silver Springs, Maryland, which until the 1990s was a typical, automobile-oriented suburb, but has recently become a multi-modal city, with medium- and high-density development clustered around a rail transit station. Although such areas are classified as suburban, they enjoy significant benefits from rail transit service as a catalyst for more efficient land use development patterns.

[20] O'Toole references *Rail Transit In America* (Litman, 2004a), acknowledging that my study indicates that regions with high quality rail transit have higher per capita transit ridership and lower per capita congestion costs, but claims that my analysis fails to account for ridership trends over time. It ignores other identified benefits such as reduced crashes, consumer cost savings and reduced operating costs per passenger-mile. It also misspells my name.

[21] O'Toole criticizes the Houston rail line for having 68 collisions with automobiles during its first year. However, the Main Street on which it operates averages about 2,000 annual vehicle collisions. Virtually all of these collisions result from motorist errors, and the high crash rate is declining as new safety features are implemented and drivers become more familiar with the rail system.