Victoria Transport Policy Institute
1250 Rudlin Street, Victoria, BC, V8V 3R7, CANADA
www.vtpi.org info@vtpi.org
Phone & Fax 250-360-1560
"Efficiency - Equity - Clarity"

Rail Transit In America

A Comprehensive Evaluation of Benefits

31 August 2006

By
Todd Litman
Victoria Transport Policy Institute

Produced with support from the
American Public Transportation Association

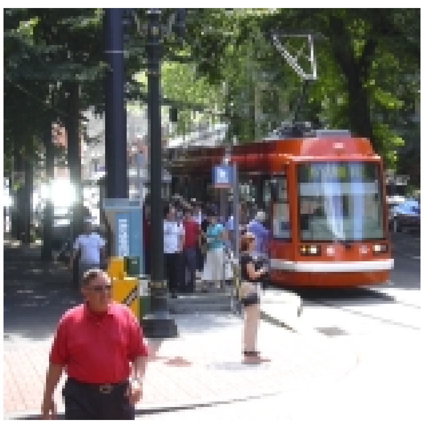


Photo: Darrell Clarke

Abstract

This study evaluates rail transit benefits based on a comprehensive analysis of transportation system performance in major U.S. cities. It finds that cities with large, well-established rail systems have significantly higher per capita transit ridership, lower average per capita vehicle ownership and annual mileage, less traffic congestion, lower traffic death rates, lower consumer expenditures on transportation, and higher transit service cost recovery than otherwise comparable cities with less or no rail transit service. This indicates that rail transit systems provide economic, social and environmental benefits, and these benefits tend to increase as a system expands and matures. This report discusses best practices for evaluating transit benefits. It examines criticisms of rail transit investments, finding that many are based on inaccurate analysis.

A condensed version of this report was published as, "Impacts of Rail Transit on the Performance of a Transportation System," *Transportation Research Record 1930*, Transportation Research Board (www.trb.org), 2005, pp. 23-29.

Contents

Executive Summary

This study investigates the impacts of rail transit on urban transportation system performance. For this study, U.S. cities were divided into three categories:

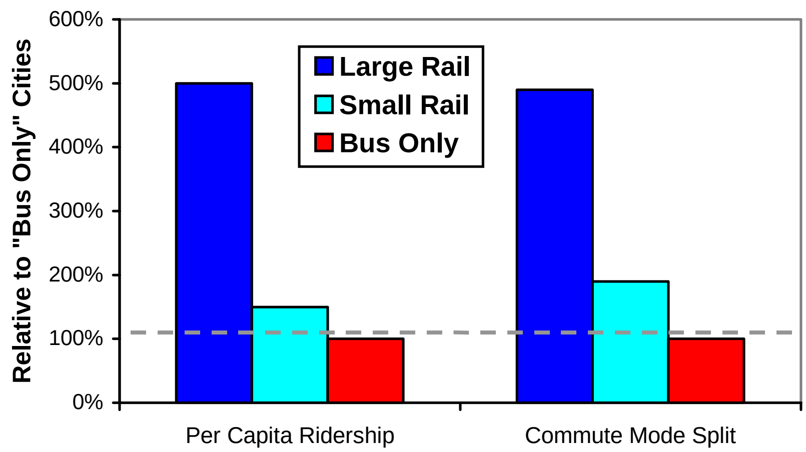
1. *Large Rail* – Rail transit is a major component of the transportation system.
2. *Small Rail* – Rail transit is a minor component of the transportation system.
3. *Bus Only* – City has no rail transit system.

When these groups are compared, Large Rail cities are found to have significantly better transport system performance. Compared with Bus Only cities, Large Rail cities have:

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 887% higher transit commute mode split (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 annual deaths per 100,000 residents).
- 14% lower per capita consumer transportation expenditures ($448 average annual savings).
- 19% smaller portion of household budgets devoted to transportation (12.0% versus 14.9%).
- 21% lower per capita motor vehicle mileage (1,958 fewer annual miles).
- 33% lower transit operating costs per passenger-mile (42¢ versus 63¢).
- 58% higher transit service cost recovery (38% versus 24%).

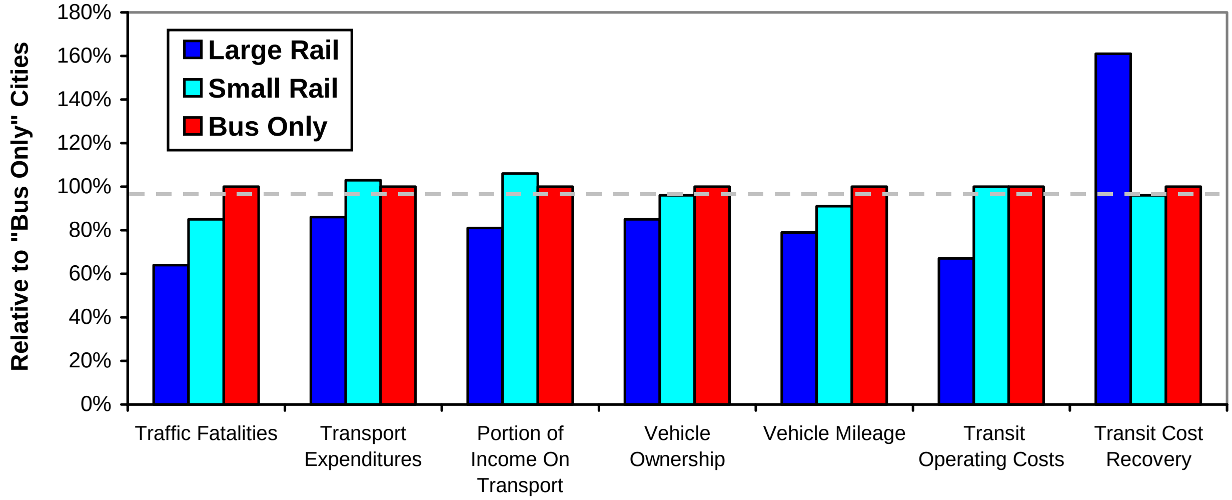
Figures ES-1 and ES-2 illustrate these benefits.

Figure ES-1 **Transit Ridership and Commute Mode Split Comparison**



This graph shows the far higher rates of transit ridership and transit commute mode split in "Large Rail" cities. The dashed line at 100% indicates "Bus Only" city values.

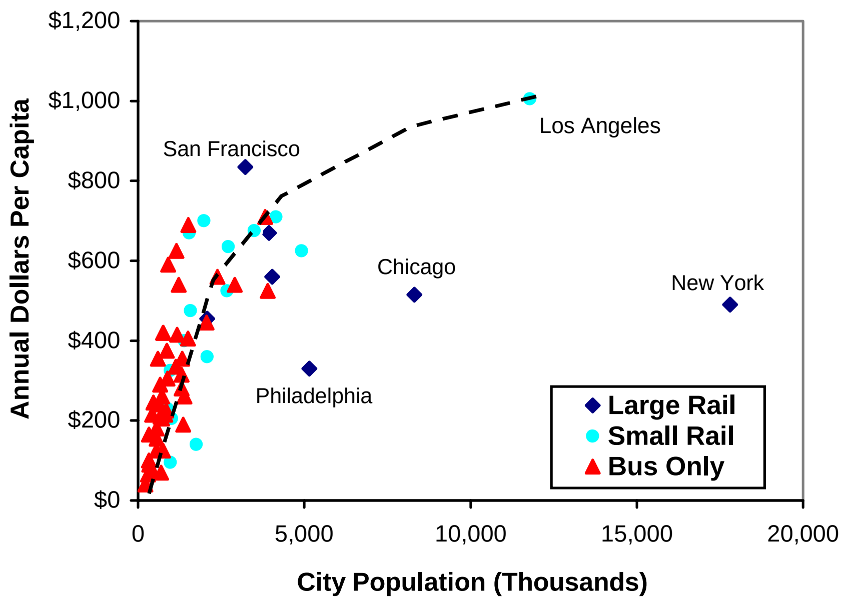
Figure ES-2 **Transportation Performance Comparison**



This graph compares different categories of cities by various performance indicators. The dashed line at 100% indicates "Bus Only" city values.

These benefits cannot be attributed entirely to rail transit. They partly reflect the larger average size of Large Rail cities. But taking size into account, cities with large, well-established rail transit systems still perform better in various ways than cities that lack rail systems. These benefits result from rail's ability to help create more accessible land use patterns and more diverse transport systems.

Figure ES-3 **Congestion Costs**



In 'Bus Only' and 'Small Rail' cities, congestion costs tend to increase with city size, as indicated by the dashed curve. But Large Rail cities do not follow this pattern. They have substantially lower congestion costs than comparable size cities. As a result, New York and Chicago have about half the per capita congestion delay of Los Angeles.

Although Large Rail cities have higher per capita congestion costs, this occurs because congestion tends to increase with city size. Taking city size into account, rail transit turns out to significantly reduce per capita congestion costs, as indicated in Figure ES-3. Matched pair analysis indicates that Large Rail cities have about half the per capita congestion costs as other comparable size cities.

U.S. rail transit services require about $12.5 billion annual public subsidy (total capital and operating expenses minus fares), about an extra $90 per Large Rail city resident. However, economic benefits more than repay these subsidies: rail transit services are estimated to provide $19.4 billion in annual congestion cost savings, $8.0 billion in roadway cost savings, $12.1 billion in parking cost savings, $22.6 billion in consumer cost savings, and $5.6 billion in traffic accident cost savings. Rail transit also tends to provide economic development benefits, increasing business activity and tax revenues. It can be a catalyst for community redevelopment. Additional, potentially large benefits include improved mobility for non-drivers, increased community livability and improved public health.

This study critiques studies which imply that rail transit is ineffective. It finds that their analysis is often incomplete, inaccurate, and biased. It examines various factors that could offset rail transit benefits, including the possibility that transit oriented development is harmful to consumers, that new rail systems cannot achieve significant benefits, that apparent benefits of rail actually reflect other factors such as city size, and that bus transit can provide equal benefits at less cost.

This study indicates that rail transit is particularly important in large, growing cities. Large cities that lack well-established rail systems are clearly disadvantaged compared with large cities that do in terms of congestion costs, consumer costs and accident risk. Rail transit can be a cost effective investment in growing cities, provided it is supported with appropriate transport and land use policies. Large cities with newer and smaller rail systems have not yet achieved the full potential benefits of rail transit, but, if their rail systems continue to develop with supportive public policies, their benefits should increase over time.

This analysis does not mean that every rail transit project is cost-effective, or that rail is always better than bus or highway improvements. It attempts to provide a fair and balanced evaluation of the advantages and disadvantages of each mode, and identify situations in which each is most appropriate. This study concludes that rail transit provides significant benefits, particularly if implemented with supportive transport and land use policies. In many situations, rail transit is the most cost effective way to improve urban transportation.

Introduction

During the last century most North American cities became increasingly automobile oriented (for this analysis "automobile" refers to any personal motor vehicle, including cars, light trucks, vans, SUVs and even motorcycles). Now, the majority of personal travel is by automobile, the majority of transportation resources (money and land) are devoted to automobiles and their facilities, and many communities have dispersed land use patterns that depend on automobile travel for access. The resulting growth in vehicle traffic creates various problems, including congestion, high road and parking facility costs, costs to consumers of owning and operating automobiles, traffic accidents, inadequate mobility for non-drivers, and various environmental impacts.

In recent years many experts and citizens have advocated diversifying our transport systems by increasing support for alternatives modes such as walking, cycling and public transit. To accomplish this many cities are making significant investments in public transit, including busways, light rail and heavy rail systems. There is considerable debate over the merits of these investments. Critics argue they are inappropriate and wasteful.

This study evaluates rail transit benefits based on a comprehensive analysis of transportation system performance in U.S. cities. It uses best available evaluation methods, based on guidance from leading experts and organizations (Cambridge Systematics, 1998; FTA, 1998: Lewis and Williams, 1999; Kenworthy and Laube, 2000; Phillips, Karachepone and Landis, 2001; HLB, 2002; Kittleson & Associates, 2003; MKI, 2003; Litman, 2004a). This analysis takes into account various performance factors, including the amount and type of travel that occurs, congestion costs, road and parking facility costs, consumer costs, accident rates, transit system efficiency and cost recovery, and various other impacts.

This study compares rail and bus transit, identifies the conditions in which each is most appropriate, and discusses the role that each mode can play in an efficient transportation system. It also describes various ways of improving transit service performance in order to increase benefits.

This study evaluates various criticisms of rail transit, including claims that it provides minimal congestion and emission reduction benefits, that it is not cost effective, and that money is better spent on roads, bus service or subsidized cars. It also examines various factors that could offset rail transit benefits, including the possibility that transit oriented development is harmful to consumers, that new rail systems cannot achieve significant benefits, that apparent benefits of rail actually reflect other factors such as city size, and that bus transit can provide equal benefits at less cost.

The Analysis

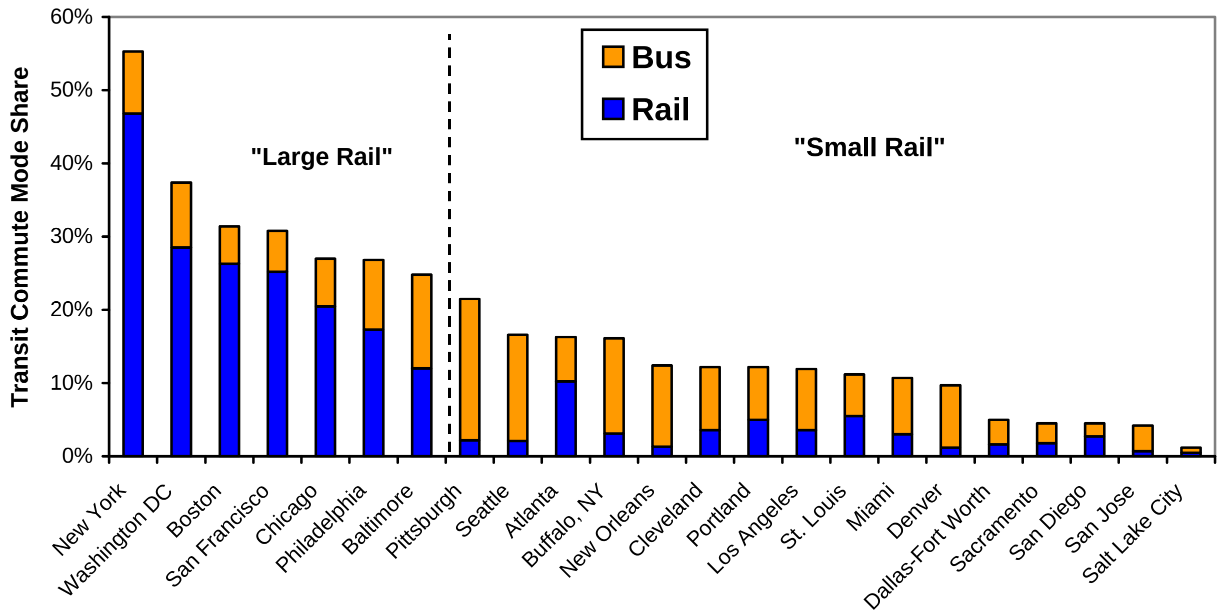
This section describes the evaluation methodologies. Analysis data are available in the "Transit Evaluation Spreadsheet" (www.vtpi.org/transit.xls). Beyond DC (www.beyonddc.com), provides maps of these cities. The " Millennium Cities Database" (Kenworthy and Laube, 1999 and 2000) provides similar analysis of major cities throughout the world.

About two dozen U.S. cities have some sort of rail transit system, but most are small and so cannot be expected to significantly effect regional transportation performance, although they may have significant impacts on a particularly corridor or district. For this study, U.S. cities and their metropolitan regions are divided into three categories:

- *Large Rail* – Rail transit is a major component of the transportation system.
- *Small Rail* – Rail transit is a minor component of the transportation system.
- *Bus Only* – City has no rail transit system.

Seven cities are classified as "Large Rail," meaning that more than 20% of commutes are by transit, and more than half of transit passenger-miles are by rail, as Figure 1 illustrates.

Figure 1 **Transit Commute Mode Share** (FTA, 2001)



This figure shows the portion of commutes by rail and bus transit. Only a few cities have rail systems large enough to significantly impact regional transportation system performance.

The next section evaluates the transportation system performance of these cities. Because Large Rail cities are relatively large, most comparisons include just the 50 largest cities to avoid skewing results with numerous small cities, and results are provided both including and excluding New York city, since New York is considered unique in the U.S.

Increased Transit Ridership and Reduced Automobile Traffic

A key issue in evaluating transit is the degree to which it attracts riders and substitutes for automobile travel, and therefore reduces traffic problems such as congestion, parking costs and accidents. Rail tends to provide higher service quality than bus transit; it is usually more comfortable, faster (particularly if grade separated) and better integrated into the urban landscape. As a result, rail transit usually attracts more riders within a given area, particularly *discretionary riders* (travelers who could drive but choose to ride transit, also called *choice riders*), and so is more effective than bus transit at reducing automobile trips (this issue is discussed later in the section "Rail versus Bus").

According to the Transit Performance Monitoring System (FTA, 2002), more than half of transit users would otherwise travel by automobile, either as a driver or passenger (some as *rideshare passengers*, using an otherwise empty seat, without increasing vehicle mileage, and others would be *chauffeured* and so do increase vehicle mileage). Below is what respondents report they would do if transit service were unavailable, for all transit systems surveyed. Automobile substitution rates are higher in larger cities.

Alternatives to Making A Transit Trip (FTA, 2002)

Drive	**23%**
Ride with someone	**22%**
Taxi/Train	**12%**
Not make trip	21%
Walk	18%
Bicycle	4%

Other studies find similar results. A user survey in Vancouver, BC found that 42% of Skytrain (rail) riders would otherwise drive, compared with 25-35% of bus riders. The table below provides information on the mode shifts that result from improved bus and rail transit service. These studies suggest that more than half of rail transit trips substitute for an automobile trip.

Table 1 **Mode Shifts By New Transit Users** (Pratt, 1999, Table 9-10)

Riders Attracted By Increased Bus Frequency		**Riders Attracted By Increased Commuter Rail Frequency**	
Prior Mode	Percentage	Prior Mode	Percentage
Own Car	18-67%	Own Car	64%
Carpool	11-29%	Carpool	17%
Train	0-11%	Bus	19%
Taxi	0-7%		
Walking	0-11%		

Bento, et al (2003) found that "rail supply has the largest effect on driving of all our sprawl and transit variables." The study concluded that a 10% increase in rail supply reduces the probability of driving by 4.2 percent, and that a 10% increase in a city's rail transit service reduces 40 annual vehicle miles of travel per capita (70 VMT if New York

City is included in the analysis), compared with just a one mile reduction from a 10% increase in bus service. That study found a 3.0 elasticity of rail transit ridership with regard to transit service supply (7.0 including New York), indicating significant network effects, that is, the more complete the transit network, the more ridership it receives.

Renne (2005) found that in major U.S. metropolitan regions transit commuting decline dramatically during the last three decades (from 19.0% in 1970 to 7.1% in 2000), but in the 103 TODs within those regions transit commuting increased from 15.1% in 1970 to 16.7% in 2000. TODs in Portland, OR and Washington D.C., which have aggressive policies to promote transit, experienced even greater ridership growth (58% for both). Households in TODs also owned fewer vehicles: only 35.3% of TOD households own two or more vehicles compared with 55.3% in metropolitan regions overall, although TOD residents have higher average incomes.

Baum-Snow and Kahn (2005) found that, although transit mode share declined in most cities between 1970 and 1990, the decline was much smaller in cities with rail transit. They found that transit commute rates declined 23% (from 30% to 23%) in “old rail” cities (cities that have well-established rail transit systems in 1970), 20% (from 8% to 6%) in “new rail” cities (cities that build rail transit lines between 1970 and 1990), and 60% (5% to 2%) in cities without rail. At a census tract level they found higher rates of transit ridership in residential areas near both old and new rail transit lines, than in similar areas not served by transit. In all three groups declines stopped between 1990 and 2000.

Rail transit tends to leverage additional automobile travel reductions by providing a catalyst for more accessible land use patterns and reduced per capita vehicle ownership. This reflects the impacts of *Transit Oriented Development* (also called *New Urbanism* and *Smart Growth*), which consists of compact, walkable, mixed-use centers (TCRP, 2004; Dittmar and Ohland, 2004). If you live near a rail transit station your neighborhood probably has various shops and services, and walkable streets, so you less likely to drive for errands such as picking up a video or taking children to school, and your household may own fewer cars than it in a more automobile-oriented location. There are many types of transit-oriented development, ranging from high-density commercial centers to small suburban villages. Many older urban neighborhoods that developed along streetcar lines retain transit oriented features decades after the rail transit service discontinued. Many of these are considered desirable neighborhoods due to those features.

Households located near rail transit stations tend to own fewer cars and drive less than households in areas without rail. This may partly reflect self-selection (households that prefer transit choose to locate in such areas), but there is evidence that residents often reduce their vehicle ownership and use after they move there. Of residents moving into the city of Portland’s new transit oriented developments, 30% own fewer cars than they did at their previous home; 22-46% commute by public transit (far higher than the 5% regional average), and 69% use public transit more often than they did in their previous community (Podobnik, 2002; Switzer, 2003). The probability of a household owning a motor vehicle decreases by about a third for residents of such communities, taking into account other demographic and economic factors (Hess and Ong, 2002).

Orenco Station in Portland, Oregon is an example of Transit Oriented Development, a medium-density, mixed use, walkable neighborhood located near a rail transit station. Residents tend to own fewer cars and drive less than they would in more automobile-oriented communities.

In other words, rail transit reduces automobile travel in two different ways: directly, when a rail passenger-mile substitutes for an automobile vehicle-mile, and indirectly when it creates more accessible land use and reduces automobile ownership in an area. Although indirect effects are difficult to measure, this and other studies suggest that they are often larger than direct effects. Research indicates that each rail transit passenger-mile represents a reduction of 3 to 6 automobile vehicle-miles, as summarized in Table 2, and in studies by Neff (1996) and Newman and Kenworthy (1999, p. 87).

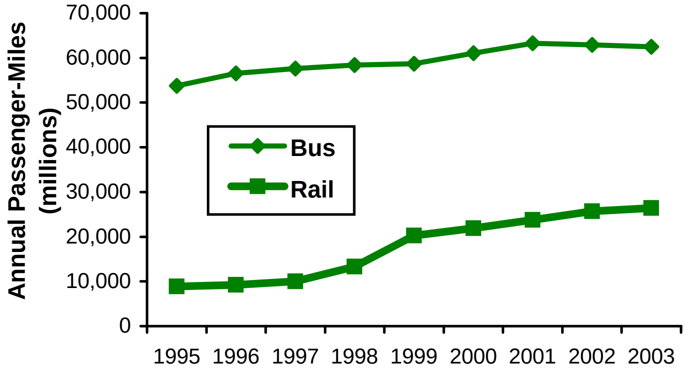
Table 2 **Transit Leverage: VMT Reductions Due to Transit** (Holtzclaw 2000)

Study	Cities	Veh.-Mile Reduction Per Transit Pass.-Mile	
		Older Systems	**Newer Systems**
Pushkarev-Zupan	NY, Chicago, Phil, SF, Bost, Clev	4	
Newman-Kenworthy	Bost., Chicago, NY, SF, DC	2.9	
Newman-Kenworthy	23 Developed/country cities	3.6	
Holtzclaw, 1991	San Francisco and Walnut Creek	8	4
Holtzclaw, 1994	San Francisco and Walnut Creek	9	1.4
MTC/Raft 2010			4.4

This table summarizes results from several studies indicating that rail transit leverages indirect vehicle travel reductions. Each transit passenger-mile represents 1.4-9.0 miles of reduced vehicle-miles. This study finds similar results, described later in this report.

A key question is whether new rail systems significantly affect transportation and land use patterns within an acceptable time period, since land use patterns generally change slowly. Evidence from some cities indicates that they can. As described above, Portland has several new transit oriented neighborhoods where residents tend to own fewer cars and drive less, and rail ridership there is growing steadily, as shown in Figures 2.

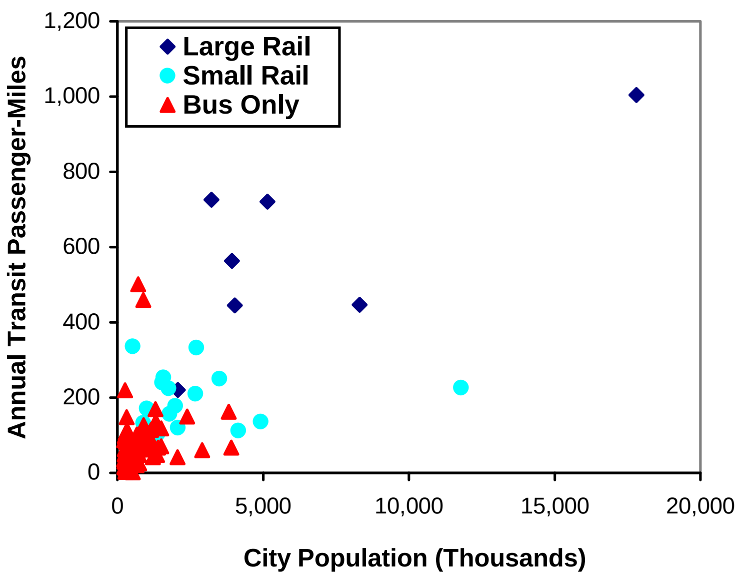
Figure 2 **Portland Transit Ridership Trends** (APTA Data)



Portland rail transit ridership is growing faster than bus ridership.

Bus transit does not generally effect land use in this way, and so does not seem to have a leverage effect on vehicle miles traveled. It is possible that bus transit programs that include incentives such as parking cash-out and location-efficient development (VTPI, 2004) could reduce vehicle travel and change land use similar to rail, but these impacts would result from the incentives, not the bus service itself.

Figure 3 **Per Capita Transit Travel** (FTA, 2001)

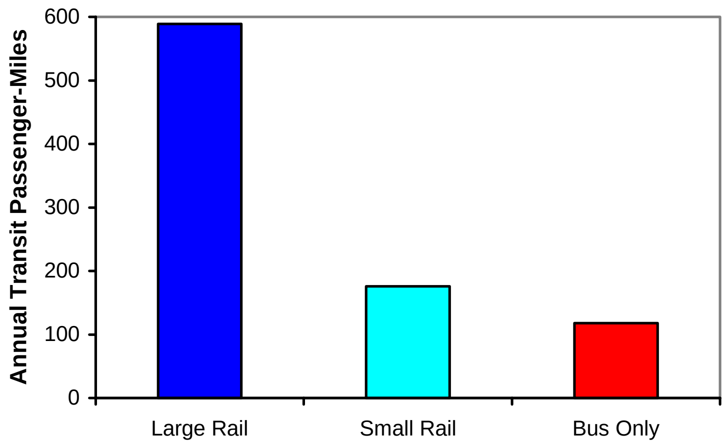


This figure shows the relationship between city size and per capita transit ridership. Transit ridership tends to increase with city size. Large Rail cities tend to be located toward the upper-left corner of the graph, indicating higher than average ridership for their population size.

This analysis finds that per-capita transit ridership is far higher in rail transit cities, as illustrated in Figures 3 and 4. Annual per capita transit passenger-miles average 589 in

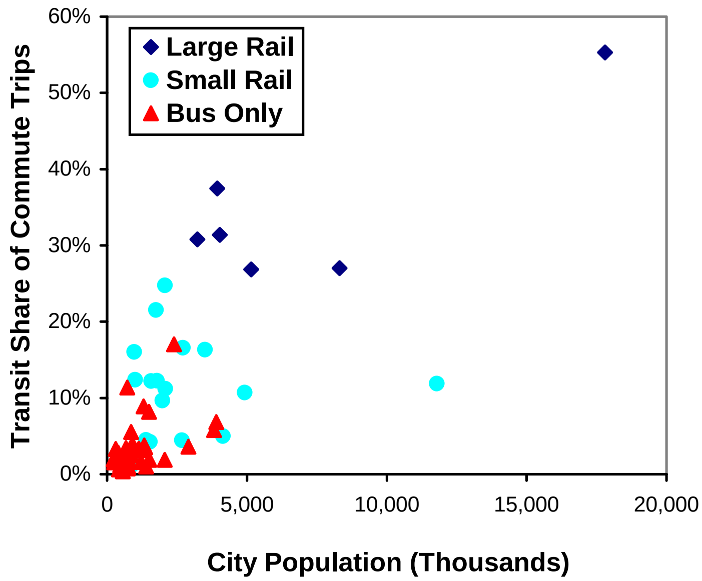
Large Rail cities (520 excluding New York), 176 passenger-miles in Small Rail cities, and 118 passenger-miles in Bus Only cities. Although this partly reflects the tendency of transit ridership to increase with city size, cities with rail systems tend to occupy the upper-left area of the graph in Figure 3, indicating high ridership for their population.

Figure 4 **Annual Per Capita Transit Ridership**



This graph compares average transit ridership between different types of cities.

Figure 5 **Transit Commute Share** (Census, 2002)



Rail cities tend to have high transit mode share relative to their size, as indicated by their clustering in the upper left of the graph.

Figure 5 shows transit commute mode share for the 50 largest U.S. cities, indicating much higher rates for Large Rail cities. Large Rail cities have 34.8% transit mode share (30.7% excluding New York), as opposed to 11.0% for Small Rail and 4.5% for Bus

Only cities. Although this can be partly explained by differences in city size, the graph shows that Large Rail cities tend to use transit far more than residents of comparable size cities that lack such systems. Transit mode share tends to be even higher for peak-period travel on rail transit corridors and destinations, such as downtowns.

Figure 6 **Transit Commute Mode Share**

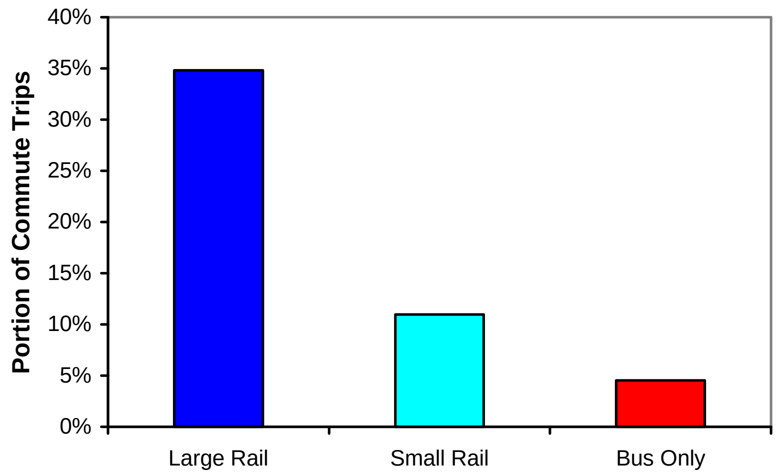
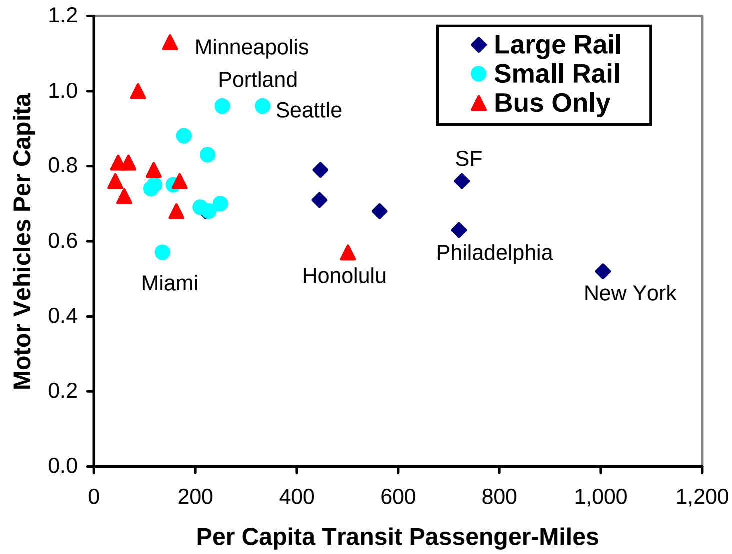


Figure 7 **Per Capita Vehicle Ownership** (BLS, 2003)



Per-capita vehicle ownership tends to decline with increased per-capita transit ridership, and is lower, on average, in Large Rail cities.

Figure 7 shows how per capita vehicle ownership declines with rail transit. In Large Rail cities residents own 0.68 vehicles per capita (0.71 excluding New York), as opposed to 0.77 in Small Rail cities, and 0.80 in Bus Only cities. This is particularly notable because Large Rail city residents have higher average incomes than residents of other types of cities, which generally increases vehicle ownership. This reduction in vehicle ownership provides consumer cost savings and helps leverage additional reductions in automobile travel beyond just the passenger-miles shifted from driving to transit, as discussed elsewhere in this report.

Figure 8 **Per Capita Private Vehicle Ownership**

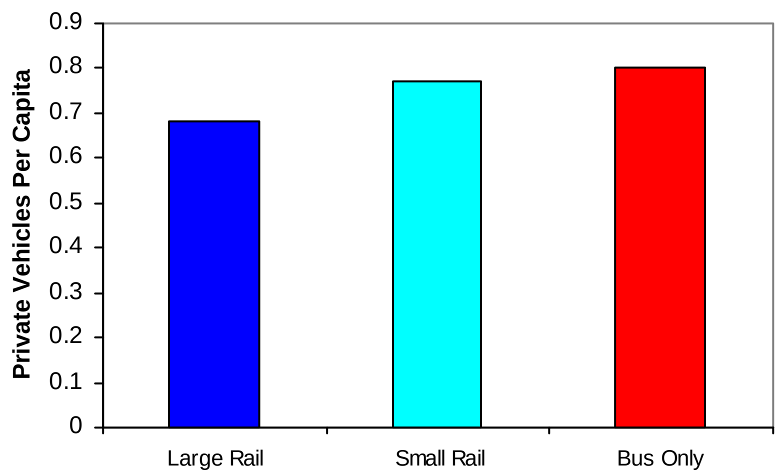
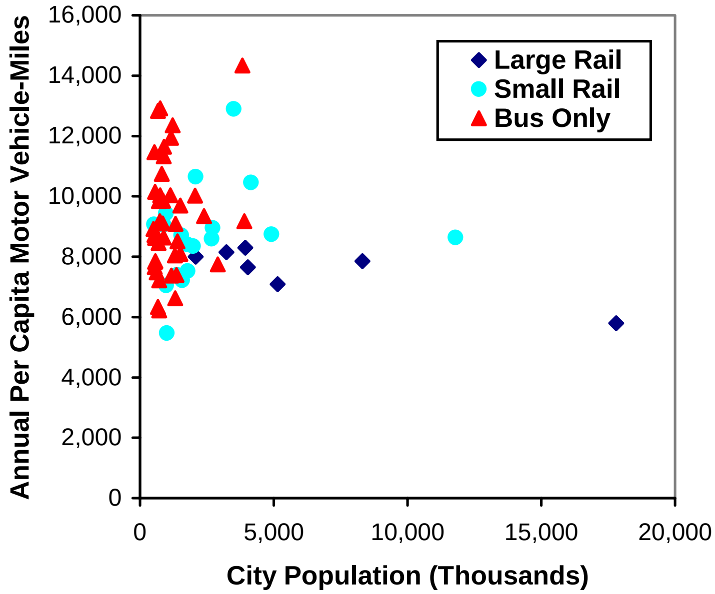


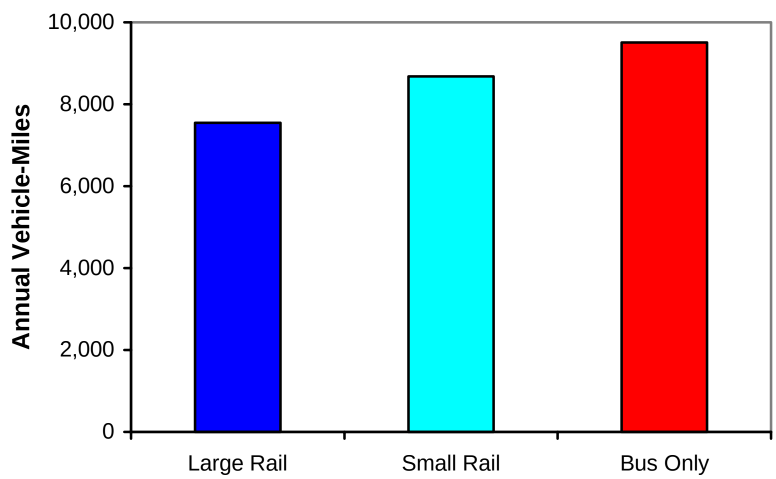
Figure 9 **Average Per Capita Annual Vehicle Mileage** (FHWA, 2002, Table 71)



Residents of Large Rail cities tend to drive significantly less than residents of other cities.

Figure 9 shows average annual per capita vehicle mileage for various cities. Residents of Large Rail cities drive an average of 7,548 vehicle-miles (7,840 excluding New York), residents of Small Rail cities average 8,679 vehicle-miles, and residents of Bus Only cities average 9,506 annual vehicle-miles. Large Rail city residents drive 12% less per year than residents of Small Rail cities, and 20% less than residents of Bus Only cities. This indicates the leverage effect of rail. Residents of Large Rail cities average 470 more transit passenger-miles than Bus Only cities, and drive 1,958 fewer vehicle-miles, a 4:1 ratio. This ratio increases to 5:1 when the analysis is limited to cities with more than 2 million population, indicating that city size by itself does not explain these differences.

Figure 10 **Annual Per Capita Vehicle-Miles**



Congestion Impacts

Traffic congestion consists of the incremental delay, stress, vehicle operating costs and pollution that each additional vehicle imposes on other road users. Congestion reduction is a primary transportation improvement objective. Special care is needed to accurately evaluate transit congestion reduction impacts ("Congestion Costs," Litman, 2003b). Traffic congestion tends to increase with city size because there are more vehicles within a given area. Rail transit systems are generally developed as cities grow large enough to experience significant congestion problems, so cities with rail transit tend to have worse congestion than those without, but it is wrong to suggest that rail transit *causes* congestion, or that congestion problems would be as bad if rail transit did not exist.

Congestion is a non-linear function: once a roadway reaches capacity even a small reduction in volumes can significantly reduce delays. For example, a 5% reduction in peak-hour traffic volumes on a road at 90% capacity can reduce delay by 20% or more. Transit can provide significant congestion reduction benefits, even if it only carries a small portion of total regional travel, because it offers an alternative on the most congested corridors. Reducing just a few percent of vehicles on such roads can significantly reduce congestion costs.

Congestion reduction benefits can be difficult to evaluate because urban traffic tends to maintain equilibrium: traffic volumes grow until congestion delays discourage additional peak-period trips. Grade-separated transit acts as a pressure-relief value, reducing the point of congestion equilibrium, as described in the box below. Although congestion never disappears, it is far less intense than would occur if such transit did not exist.

How Transit Reduces Traffic Congestion

Urban traffic congestion tends to maintain equilibrium. If congestion increases, people change destinations, routes, travel time and modes to avoid delays, and if it declines they take additional peak-period trips. If roadway capacity increases, it will be partly filled by this latent demand (potential additional peak-period vehicle trips). Reducing this point of equilibrium is the only way to reduce congestion over the long run. The quality of travel alternatives has a significant effect on this equilibrium: If alternatives are inferior, few motorists will shift mode and the level of equilibrium will be high. If travel alternatives are relatively attractive, more motorists will shift modes, resulting in a lower equilibrium. Improving travel options can therefore benefit all travelers on a corridor, both those who shift modes and those who continue to drive. Shifts to alternative modes not only reduce congestion on a particular highway, they also reduce traffic discharged onto surface streets, providing "downstream" congestion reduction benefits.

To reduce congestion, transit must attract discretionary riders (travelers who have the option of driving), which requires fast, comfortable, convenient and affordable service. When transit is faster and more comfortable than driving, a portion of travelers shift mode until congestion declines to the point that transit is no longer faster. As a result, the faster and more comfortable the transit service, the faster the traffic speeds on parallel highways. This theory is supported by studies which find that door-to-door travel times for motorists tend to converge with those of grade-separated transit (Mogridge, 1990; Lewis and Williams, 1999; Vuchic, 1999), and by studies such as this one, which find that congestion costs decline in cities with grade-separated transit systems.

Rail transit trips are often slower than automobile trips. Light rail 15.4 miles per hour (MPH), heavy rail 20.3 MPH, and commuter rail 31.6 MPH (see table below), while automobile travel averages about 35 MPH overall (NPTS, 1999). Transit travel speeds are particularly high when measured door-to-door, taking into account walking and waiting links. Travel surveys generally find that transit commute times are about double those of automobile commutes. As a result, it can be argued that transit congestion reductions are irrelevant since transit trips generally take longer than the same trips by car. However, it is important to take several other factors into account when comparing transit and automobile travel times and speeds.

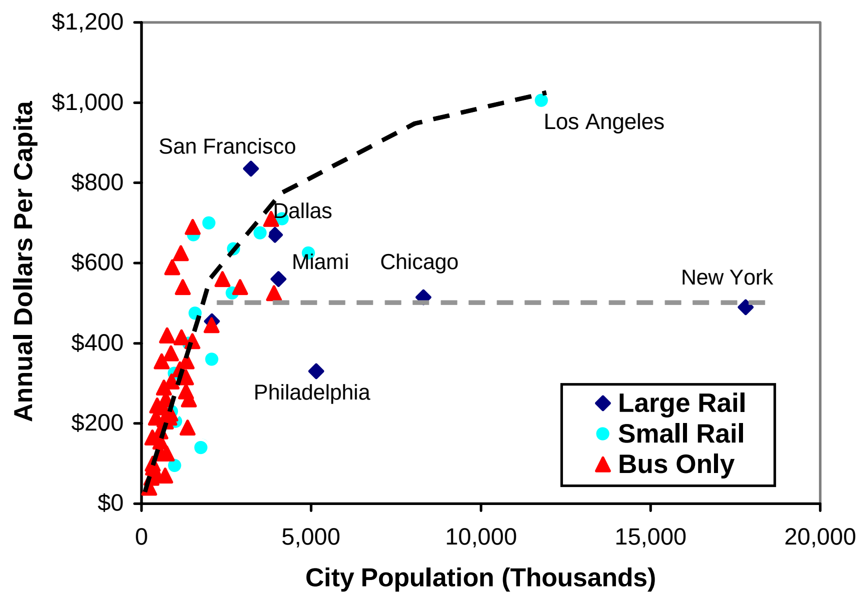
Automobile travel speeds tend to be lower, and commute travel times higher, in large cities where rail transit is most common. For example, although automobile commute speeds average 39 mph in rural areas, they average only 33 mph in cities with more than 3 million residents (NPTS, 1999). Automobile travel speeds tend to be even slower on the congested urban corridors where rail transit is most common. That national or regional average automobile travel speeds are higher than average rail speeds is irrelevant; what matters is their relative travel speeds on a particular corridor. Even if transit is slower than driving on average, in some situations rail is faster, because it is grade separated. The criticism that transit is slower than driving can be considered an argument for more rail transit improvements to increase its speeds, rather than an argument against rail.

Even if transit travel takes more time measured by the clock, the additional time may have a lower cost to travelers than the same amount of time spent driving, particularly under congested conditions, because it imposes less stress. Passengers using high-quality transit (each passenger has a comfortable seat, and vehicles are safe, clean, reliable and not too noisy), can read, work and rest. Various studies indicate that consumers place a higher cost on time spent driving than travel as a passenger, and drivers' time costs increase as congestion becomes more intense. According to current travel time cost values, passengers' travel time is charged at 35% average wage rates, while drivers' time is charged at 50% of wage rates, with a premium of 33% for Level of Service (LOS) D, 67% for LOS E, and 100% for LOS F ("Travel Time," Litman, 2003b). Although some agencies apply different values, there is little disagreement among experts over the basic concept that, for an average consumer, time spent driving in congestion incurs a higher cost than the same amount of time spent as a comfortable passenger.

Of course, each trip is unique. For some trips transit is simply not an option, because it does not serve a destination, or travelers need to carry special loads, or to have a vehicle available at work. Some travelers cannot take rail because they want to smoke while commuting, or because they have difficulty with the walking links of a transit trip. Some people dislike riding transit, or enjoy driving even in congested conditions. But that does not negate the benefits of rail transit: if quality transit is available, travelers will self-select driving or transit based on their needs and preferences. This maximizes transportation system efficiency (since shifts to transit reduce traffic and parking congestion) and consumer benefits (since it allows consumers to choose the option they prefer).

The Texas Transportation Institute's (TTI's) annual *Urban Mobility Study* is often used to compare congestion costs between U.S. cities. It provides seven congestion indicators. Some indicators, such as per-capita congestion delay or cost, are more appropriate than others for evaluating transit impacts, because they account for time savings resulting from mode shifts and more accessible land use patterns. Measured in this way, Large Rail cities have substantially less congestion than other comparable size cities, as illustrated in Figure 11. For cities with Small Rail or Bus Only transit systems, traffic congestion increases substantially with city size, but cities with Large Rail transit systems do not follow this pattern.

Figure 11 **Congestion Costs** (TTI, 2003)

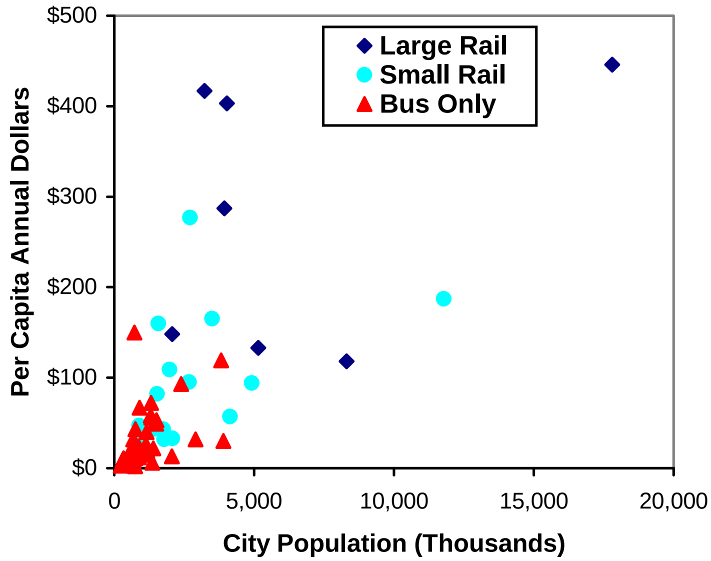


In Bus Only and Small Rail cities, traffic congestion costs tend to increase with city size, as indicated by the dashed curve. But Large Rail cities do not follow this pattern. They have substantially lower congestion costs than comparable size cities. As a result, New York and Chicago have about half the per capita congestion delay as Los Angeles.

Analysis by Winston and Langer (2004) indicates that motorist and truck congestion delay declines in a city as rail transit mileage expands, but increase as bus transit mileage expands. This appears to occur because buses attract fewer travelers from driving, contribute to traffic congestion themselves, and have less positive impact on land use accessibility. Garrett (2004) found that traffic congestion growth rates declined somewhat in some U.S. cities after light rail service began. 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. Between 1998 and 2003, Portland's population grew 14%, yet per capita congestion delay did not increase, possibly due to rail transit investments which significantly increased transit ridership during that period (TTI, 2005). Other studies find similar results (LRN, 2001).

Nelson, et al (2006) used a regional transport model to estimate transit system benefits, including direct users benefits and the congestion-reduction benefits to motorists. They found that rail transit generates congestion-reduction benefits that exceed subsidies.

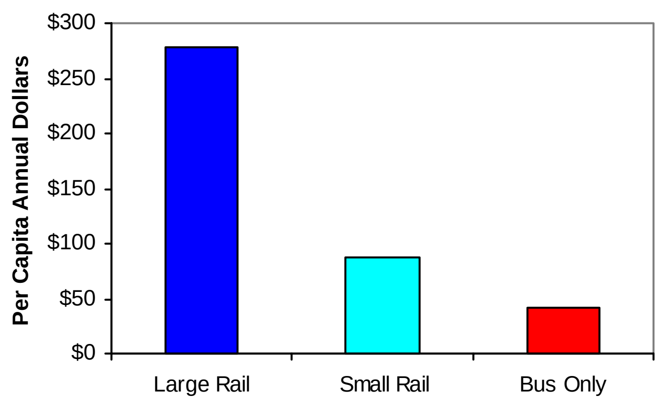
Figure 12 **Transit Congestion Cost Savings** (TTI, 2003)



This figure illustrates per capita congestion cost savings due to transit service.

TTI estimates congestion cost savings from public transit services. Figures 12 and 13 compare this benefit for various cities. Large Rail cities have much greater transit congestion reductions than other cities. Of the 50 largest cities, Large Rail cities average $279 savings per capita, compared with $88 Small Rail cities, and $41 for Bus Only cities. These savings total more than $14.0 billion in Large Rail cities, $5.4 billion in Small Rail cities, and $1.8 billion dollars in Bus Only cities (considering only the 50 largest U.S. cities), indicating that rail provides $19.4 billion annual congestion cost savings. These savings approximately equal total U.S. public transit subsidies.

Figure 13 **Transit Congestion Cost Savings** (TTI, 2003)



Matched pair analysis is used to determine whether these differences in congestion costs result from differences in city size. Three Large Rail cities (New York, Chicago and Philadelphia) are compared individually with three similar size Small Rail cities (Los Angeles, Miami and Dallas). The three Small Rail cities experience about twice the congestion delays as their matched Large Rail cities.

Table 3 **Congestion Delay In Six Largest U.S. Cities**

Large Rail			Small Rail		
City	Population	Congestion Delay	City	Population	Congestion Delay
New York	17,799,861	25	Los Angeles	11,789,487	52
Chicago	8,307,904	27	Miami	4,919,036	33
Philadelphia	5,149,079	17	Dallas	4,145,659	36
Averages	*7,814,211*	*23*	*Averages*	*5,213,545*	*40*

Of the six largest U.S. cities, the three with Large Rail systems have about half the congestion delay as the three that lack such systems.

Baum-Snow and Kahn (2005) found significantly lower average commute travel times in areas near rail transit than in otherwise comparable locations that lack rail, due to the relatively high travel speeds of grade-separated transit compared with commuting by automobile or bus under the same conditions. They estimate that these savings total 50,000 hours per day in Washington DC, and smaller amounts in other cities. Another indicator of transit's congestion reduction benefits is the increased traffic delay that occurs in rail-oriented cities when the transit system stops for any reason, such as a mechanical failure or strike.

This leaves little doubt that rail transit reduces per capita congestion costs. However, this does not mean that such cities lack congestion. In fact, congestion, measured as roadway level of service or average traffic speeds, is often quite intense in these cities. However, people in these cities have travel alternatives available on congested corridor, and tend to drive less, and so they experience significantly less congestion delay each year.

Critics sometimes claim that rail transit does not reduce traffic congestion, ignoring the evidence presented in this and other studies. In some cases they ignore factors such as city size, and so conclude incorrectly that rail transit causes congestion. They often use inappropriate congestion indicators, such as the *Travel Time Index*, which only measures delay per unit of roadway (automobile and bus) travel, and so ignores delay reductions when people shift to transit, and from transit-oriented development that reduces travel distances. That index actually implies that congestion declines if residents *increase* their vehicle mileage and total travel time, for example, due to more dispersed land use, provided the additional driving occurs in less congested conditions.

Cost Effectiveness

Rail transit systems may appear costly due to various special factors:

- New transit projects must overcome decades of underinvestment in grade-separated transit.
- Transit must provide a high quality of service to attract discretionary riders out of their cars.
- Rail transit is generally constructed in the densest part of a city where any transportation project is costly, due to high land values, numerous design constraints, and many impacts.
- Rail transit projects often include special amenities such as community redevelopment and streetscape improvements which provide additional benefits, besides just mobility.
- Rail transit projects include tracks, trains, stations, and sometimes parking facilities. It is inappropriate to compare rail system costs with just the cost of adding roadway capacity; comparisons should also include vehicle and parking costs needed for automobile travel.

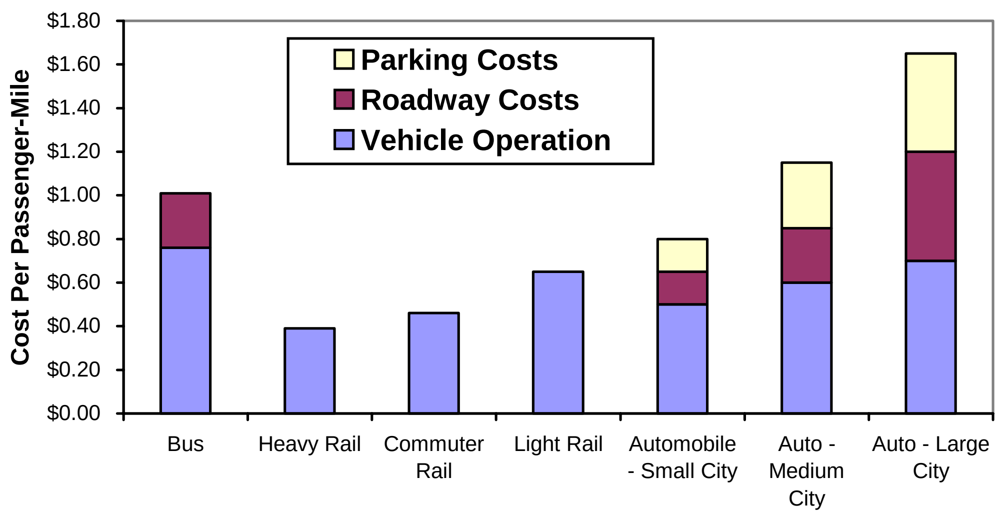
Table 4 **Typical Automobile Commute Trip Costs** (Litman, 2003b)

	Small City	**Medium City**	**Large City**
Average Vehicle Costs (per vehicle-mile)	50¢	60¢	70¢
Roadway Capacity Cost (per vehicle-mile)	15¢	25¢	50¢
Parking (per day/per mile for 20-mile round trip)	$3.00 (15¢)	$6.00 (30¢)	$9.00 (45¢)
Total Per Mile Costs	*$1.05*	*$1.70*	*$2.35*

This table illustrates typical costs for an automobile commute for various size cities.

Most people never purchase a road or individual parking space and so greatly underestimate the full cost of accommodating additional urban automobile travel, taking into account vehicle, road and parking costs. Table 4 and Figure 14 show typical estimates of these costs.

Figure 14 **Average Costs By Mode** (APTA, 2002; Litman, 2003b)

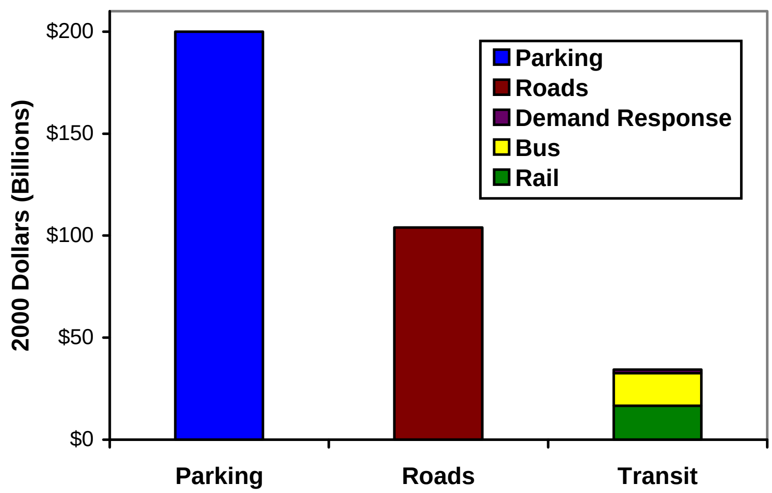


This figure compares costs per passenger-mile of various modes. Rail transit costs are usually less than combined road, vehicle and parking costs, particularly in large cities.

Critics often claim that rail transit is more costly than bus or automobile transport, but this often reflects faulty analysis. They usually consider just a small portion of total transit benefits and underestimate the actual costs of accommodating additional automobile travel under the same conditions, taking into account the high costs of increasing road and parking capacity on major urban corridors. When all benefits and costs are considered, rail transit often turns out to be the most cost effective way of accommodating additional urban travel.

Claims that rail transit projects consume an excessive portion of transportation budgets also tend to reflect incomplete analysis. For example, transportation expenditures by federal, state and local governments totaled $167 billion in 2000, of which $104 billion was for roads, $15.9 billion for bus transit, $1.8 billion for demand response services and $16.7 billion for rail. The cost of parking at destinations is estimated to total more than $200 billion annually (Litman, 2003b). Rail transit expenditures equal about 5% of total automobile facility costs (roads and parking), as illustrated in Figure 15.

Figure 15 **Transportation Expenditures** (Litman, 2003b; BTS, 2003, Table 3-29a)



Transit subsidies represent about 19% of total government expenditures on transportation services, less than half of which is for rail transit. Rail transit represents less than 5% of total expenditures on roads, non-residential parking and transit.

When a major rail transit project is under construction most of the cost is included in a particular transportation agency's capital budget, so for a few years it appears relatively large. This is no different than other major investments, including highway projects and bridges, or a household's automobile purchase, which may appear exceptionally large compared with a single year's budget. When averaged over a larger time period (rail transit capital investments have 20-50 year operating lives), or over several cities, transit capital projects represent a small portion of total government transportation expenditures.

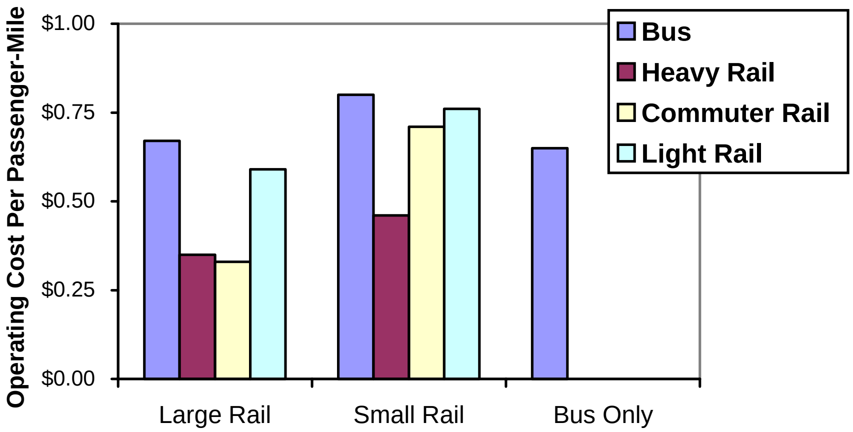
Rail systems are sometimes justified for special reasons. For example, New Orleans and Seattle have popular tourist trolley systems which have high costs per passenger-mile, because they are small and serve short trips, but are considered worthwhile investments because they contribute a special ambiance and attract visitors. Rail transit may also be considered worthwhile to support strategic development objectives, or to allow a commercial center to grow. It is simply not economically possible for a center to expand beyond about 5,000 employees without a significant portion of commuters arriving by transit, due to limited road and parking capacity. Because diesel buses are noisy and smelly, large bus terminals are less suitable than rail stations for accommodating large numbers of transit passengers. Although rail systems may seem costly, a significant portion of their costs are often offset by increased property values, business activity and productivity gains (Smith and Gihring, 2003).

Special care is needed when comparing automobile and transit funding. Transit is funded to help achieve various objectives, including congestion reduction, road and parking facility cost savings, consumer cost savings, basic mobility for disadvantaged people, increased safety, pollution reduction and support for strategic development objectives. For efficiency-justified funding (to reduce costs such as congestion, facility costs, accidents and pollution) transit and automobile transport can be compared using measures of cost effectiveness, such as costs per passenger-mile or benefit/cost ratio, to identify the cheapest option. In that case, there is no particular reason to subsidize a transit trip more than an automobile trip, provided all costs (including road and parking costs, traffic services, congestion and crash risk impacts on other road users, and environmental impacts) are considered.

However, for equity-justified service (providing basic mobility to disadvantaged people) there are reasons to subsidize transit more than automobile travel, because transit bears additional costs to accommodate people with disabilities (such as wheelchair lifts), and many non-drivers have low incomes, so greater public subsidies are justified on equity grounds. Since many of these people cannot drive, the alternative must include the cost of a driver, so transit costs should be compared with taxi service costs (or a combination of taxi and chauffeured automobile travel, taking into account the value of time by family members and friends who drive), not simply with vehicle costs.

Care is also needed when comparing different types of transit. Buses are generally cheaper to operate than trains per vehicle-mile, but trains have more capacity and so are cheaper per passenger-mile on routes with high demand. Similarly, costs per vehicle-mile or vehicle-hour tend to be higher in larger cities, due to increased congestion and higher wages, but ridership also tends to be higher, reducing costs per passenger-mile. For example, according to APTA data, bus employees earn an average of $46,139 annually in wages and benefits, compared with $81,307 for regional rail transit employees, due to differences in job classifications and prevailing wage rates.

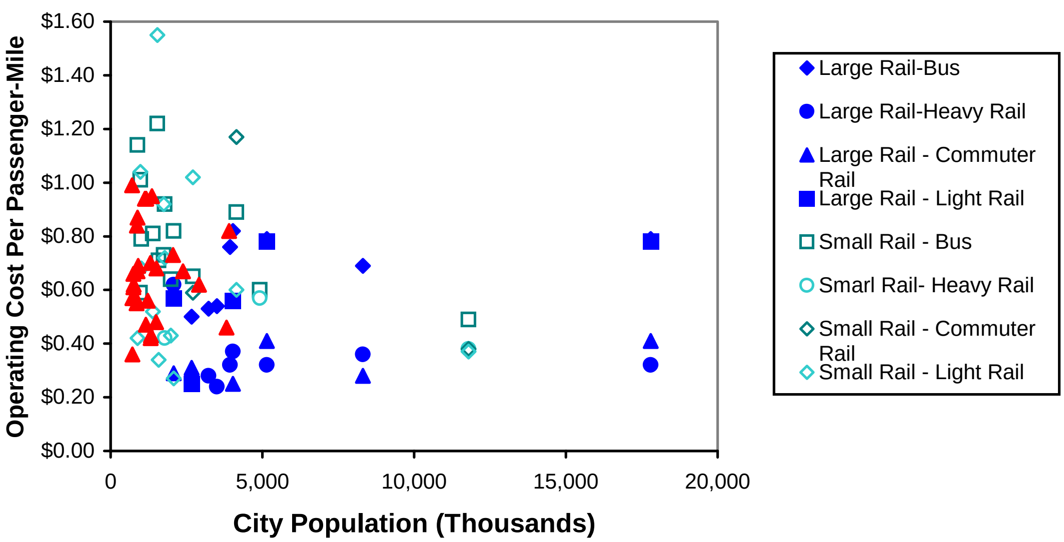
Figure 16 **Average Operating Cost By Mode and City Category** (APTA, 2002)



Transit operating costs tend to be lower in Large Rail cities than Small Rail cities. Bus Only cities have slightly lower bus operating costs, probably due to lower wages and less congestion.

Operating costs per transit passenger-mile are generally lower in Large Rail cities than in Small Rail cities, and heavy and commuter rail costs are lower than light rail and bus costs, as illustrated in figures 16 and 17.

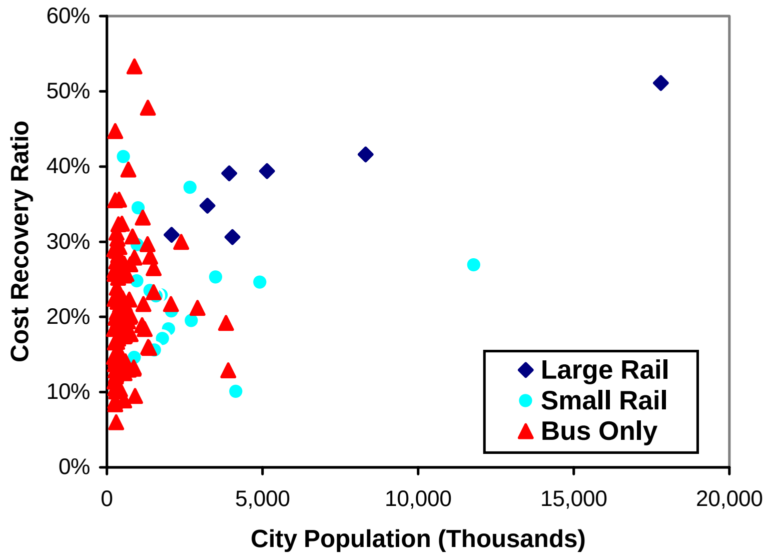
Figure 17 **Operating Cost By Mode And City Category** (APTA, 2002)



Large Rail transit systems tend to have lower operating costs than Small Rail systems.

Rail transit systems also tend to have greater cost recovery, that is, a larger portion of operating costs are paid by fares, as illustrated in Figure 18. Transit cost recovery (including both rail and bus services) averages 38% for Large Rail systems (36% excluding New York), 24% for Small Rail systems, and 21% for Bus Only systems.

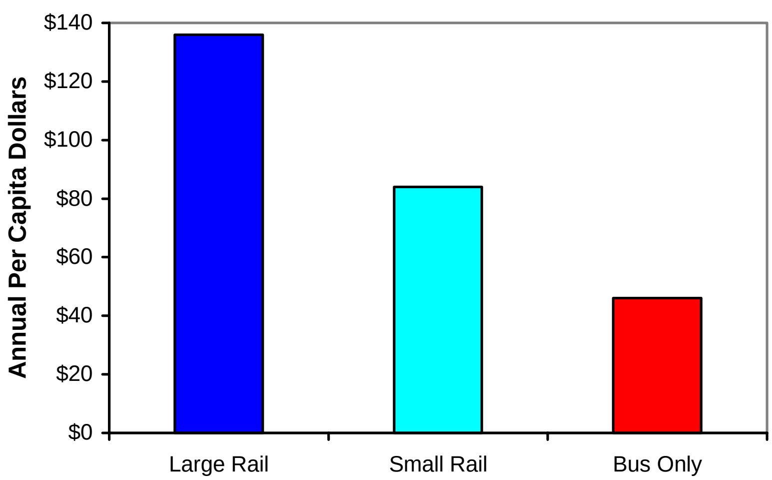
Figure 18 **Transit System Cost Recovery** (FTA, 2001)



Transit system cost recovery (the portion of total operating costs paid by fares, including both rail and bus services) tends to be higher for Large Rail than for Small Rail or Bus Only systems, even accounting for city size. This suggests that rail transit can increase cost effectiveness.

Some critics argue that rail transit absorbs an excessive portion of transit funding, reducing funding for bus services. But total transit funding tends to increase with rail service as indicated in Figure 19. Thompson and Matoff (2003) find that Bus Only cities such as Columbus, Ohio spend less per capita on transit than cities with rail systems, such as Portland, San Diego and Seattle. This suggests that rail and bus investments are complements rather than substitutes, because decision-makers realize the importance of creating an integrated transit system. This may not be true in every case, but there is no evidence that rail system development necessarily reduces bus funding or service quality.

Figure 19 **Annual Per Capita Transit Expenditures**



Road and Parking Cost Savings

To the degree that transit substitutes for automobile travel, it reduces road and parking facility costs. Table 5 illustrates an estimate of these savings, based on estimates of automobile trip substitution rates, and cost values from Table 4.

Table 5 **Estimated Road and Destination Parking Cost Savings**

	Large Rail	Small Rail	Totals
Transit Passenger-Miles (millions)	32,107	8,957	
Portion of Transit Passenger-Miles by Rail	80%	31%	
Portion of transit trips that substitute for a car trip.	60%	50%	
Avoided Roadway Costs (cents per veh.-mile)	$0.50	$0.25	
Total Roadway Cost Savings (millions)	*$7,697*	*$349*	*$8,046*
Avoided Parking Costs (cents per vehicle-mile)	$0.40	$0.30	
Total Parking Cost Savings (millions)	*$6,158*	*$419*	*$6,577*
Total Road and Parking Savings (millions)	**$13,855**	**$768**	**$14,623**

This table shows estimated road and parking cost savings from automobile travel shifted to transit.

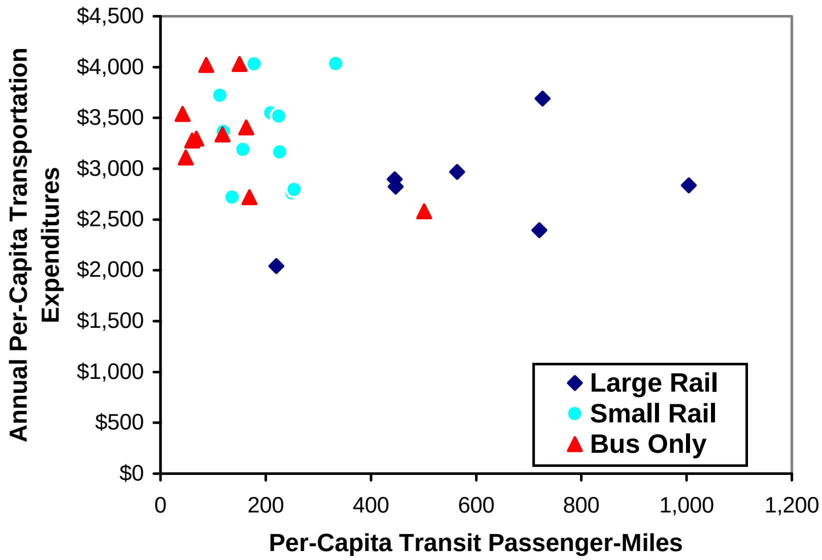
These estimates are conservative because they do not account for the additional savings from the automobile trip reductions leveraged by rail transit, due to reductions in vehicle ownership and improved accessibility due to transit oriented development. Residents in such communities walk rather than drive for more local errands, providing additional road and parking cost savings for those trips.

In addition, reduced vehicle ownership provides residential parking cost savings. Residential parking costs range from about $400 annually for a surface lot in an area with low land values, up to $2,600 annually for underground parking (Litman, 2004a). Parking costs tend to be particularly high in dense urban areas, so it is reasonable to estimate that parking costs average at least $800 in rail transit cities. Rail transit city residents would need to park 6.1 million more vehicles if they owned automobiles at the same rate as Bus Only city residents. At $800 per space, residential parking cost savings for these vehicles total $4.8 billion. Total road and parking cost savings from rail therefore total more than $20 billion dollars annually, substantially more than total rail transit subsidies.

Consumer Financial Impacts

About 18% of household expenditures are spent directly on vehicles and transit fares (BLS, 2003). Rail transit reduces these costs. Large Rail city residents spend an average of $2,808 on vehicles and transit ($2,803 excluding New York), compared with $3,350 in Small Rail cities, and $3,332 in Bus Only cities, despite 7% higher average incomes and longer average commutes, which normally increase transport expenditures. Figures 20 and 21 illustrate these differences.

Figure 20 **Transport Expenditures** (BLS, 2003)



Per-capita transportation expenditures tend to decline with increased transit ridership.

Large Rail city residents save $22.6 billion in total compared with what consumers spend on transportation in Bus Only cities. These savings are greater than all transit subsidies in the U.S., indicating substantial net economic benefits.

Figure 21 **Annual Per Capita Consumer Expenditures on Transportation**

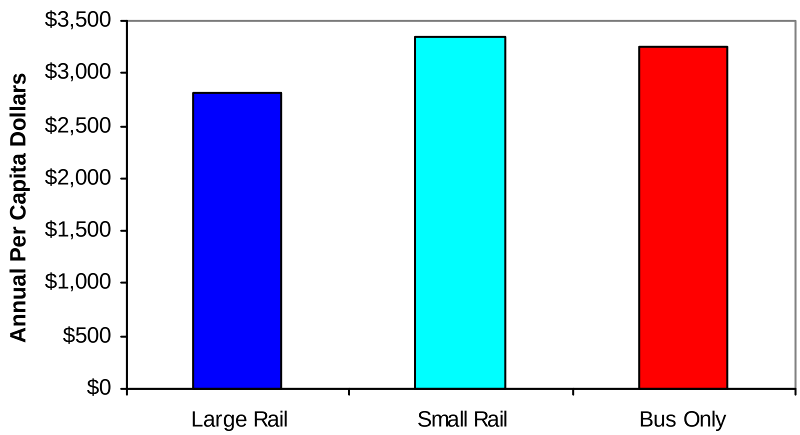
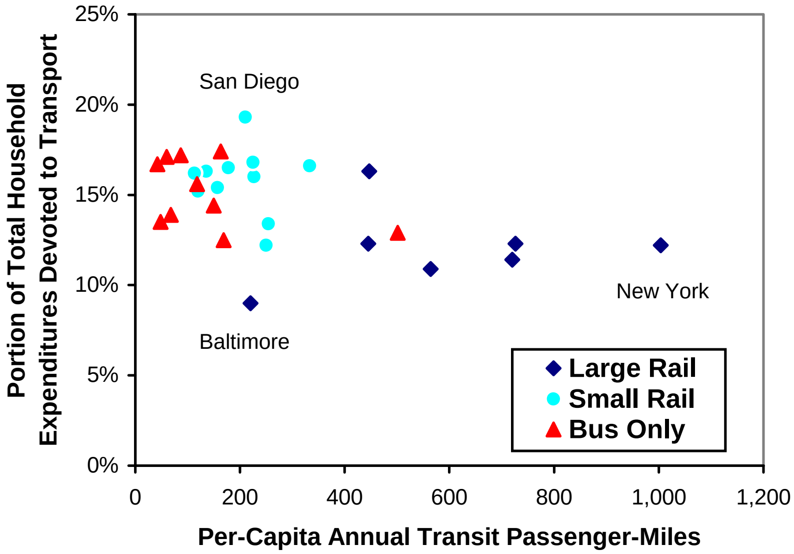


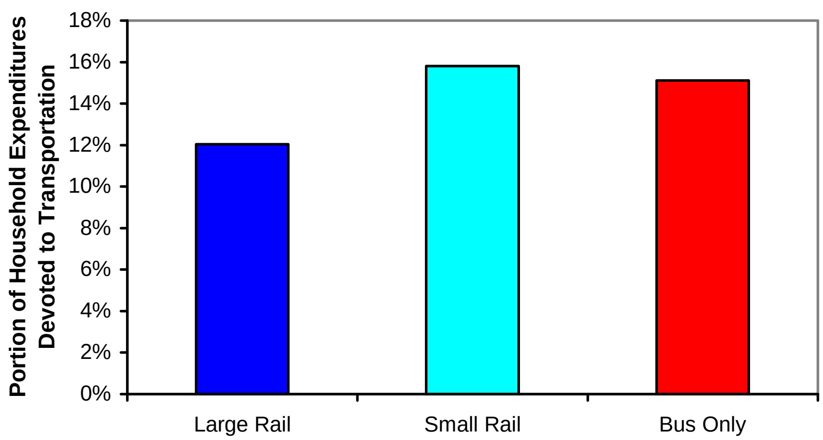
Figure 22 **Percent Transport Expenditures** (BLS, 2003)



The portion of total household expenditures devoted to transportation (automobiles and transit) tends to decline with increased transit ridership, and is lower, on average, in Large Rail cities.

Figures 22 and 23 compare transportation as a percentage of household expenditures, which takes into account the higher wages in large cites. Large Rail city residents devote just 12.0% of their income to transportation (this does not change if New York is excluded), compared with 15.8% in Small Rail cities, and 14.9% in Bus Only cities. International comparisons show similar patterns (Kenworthy and Laube, 2000).

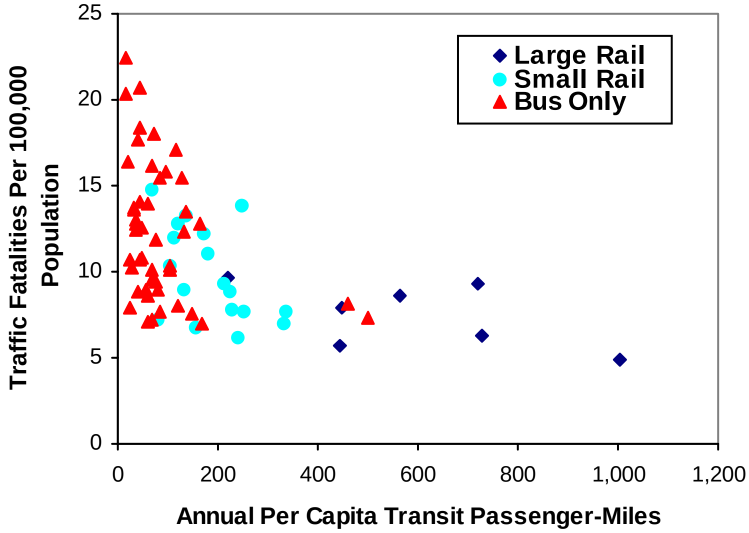
Figure 23 **Percent Transport Expenditures**



Safety Impacts

Traffic accidents impose significant costs. Despite significant traffic safety efforts, vehicle accidents continue to be the largest cause of deaths and disabilities for people in the prime of life, imposing many billions of dollars in economic losses annually.

Figure 24 **Traffic Deaths** (FTA, 2001)



Per capita traffic fatalities (including automobile occupants, transit occupants and pedestrians) tends to decline with increased transit ridership. Rail cities tend to have lower traffic fatalities.

Rail transit cities have significantly lower per capita traffic death rates, as illustrated in Figures 24 and 25. Large Rail cities average 7.5 traffic fatalities per 100,000 population (7.9 excluding New York), Small Rail cities average 9.9, and Bus Only cities average 11.7, a 40% higher rate. If Large Rail cities had the same fatality rate as Bus Only cities there would be about 2,500 more annual traffic deaths, plus increased disabilities, injuries and property damages. This represents $50 billion in annual savings, based on USDOT recommended values for crash reduction benefits.

Figure 25 **Annual Per Capita Traffic Deaths**

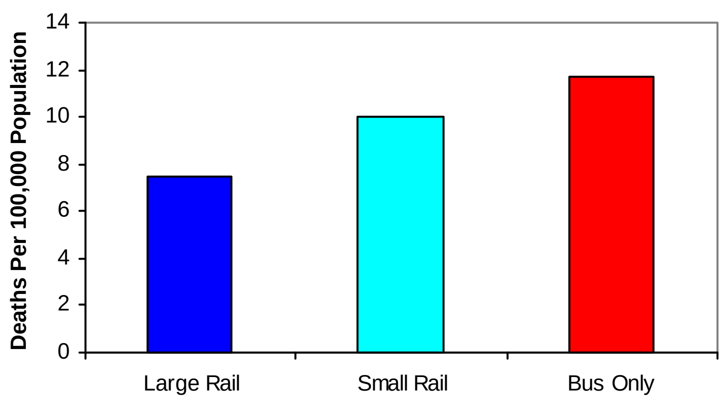
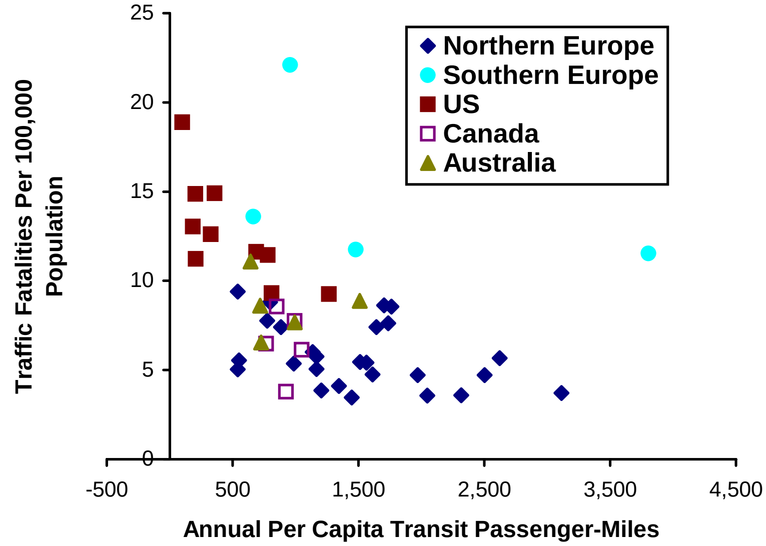


Figure 26 **International Traffic Deaths** (Kenworthy and Laube, 2000)



International data indicate that crash rates decline with increased transit ridership.

Figure 26 shows international data which also indicate that per capita traffic fatalities decline with increased transit ridership (see additional discussion in Litman, 2004d). Table 6 shows per capita traffic fatality and injury crash rates for various modes, indicating that in the U.K., where urban rail transit systems are well established, deaths and injury rates are quite low compared with other modes.

Table 6 **UK Crash Rates Per Billion Pass-Kms** (Steer Davies Gleave, 2005, Table 7.3)

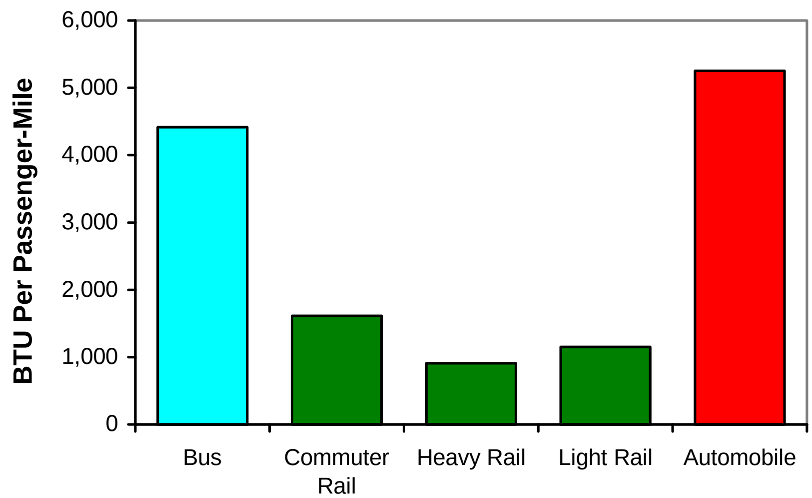
Mode	Killed	Killed and Injured
Motorcycle	112	5,549
Cycling	33	4,525
Walking	48	2,335
Private car	3	337
Bus or Coach	0.1	196
Heavy Rail	0.1	13
Light Rail	0.00002	0.00007

British data indicate that rail transit has very low traffic fatality rates per passenger-kilometer compared with other modes.

Energy and Emission Reductions

Rail transit can provide substantial energy conservation and emission reduction benefits. Rail travel consumes about a fifth of the energy per passenger-mile as automobile travel, due to its high mechanical efficiency and load factors (Figure 27). Electric powered rail produce minimal air and noise emissions. Rail provides even greater energy and emission reduction benefits when it leverages additional reductions in vehicle travel. International comparisons indicate that per capita energy consumption declines with increased transit use (Kenworthy and Laube, 2000).

Figure 27 **Transit Energy Consumption** (Shapiro, Hassett, and Arnold)



Rail travel consumes much less energy than bus or automobile travel.

Residents of Large Rail cities drive 12-20% fewer vehicle-miles than residents of Small Rail or Bus Only cities, due to rail's leverage effect on vehicle ownership and land use. This suggests that rail transit can provide about half the per capita transportation CO_2 emission reductions required to meet the Kyoto targets. In addition:

- Rail transit emission reductions can be particularly large since transit oriented development tends to reduce short vehicle trips which have high per-mile energy consumption and emission rates due to cold starts and congested conditions. As a result, each 1% of mileage reduced typically reduces air emissions by 2-3%.
- Rail tends to reduce emissions in highly populated areas, such as city centers, major roadways and transit terminals, and so reduces people's exposure to harmful emissions such as CO, toxics and particulates, particularly compared with diesel buses.
- Transit encouragement strategies that increase ridership, and transit oriented development policies, tend to have large energy conservation and emission reduction benefits.
- Energy conservation and pollution emission reductions are just two of many potential benefits of rail transit. When these additional benefits are considered, rail investments can be a cost effective way to achieve environmental objectives.

Economic Development Impacts

Economic Development refers to progress toward a community's economic goals, including increased productivity, employment, income, business activity, property values, redevelopment and tax revenue. Transit in general and rail transit in particular can provide various economic development benefits (Cambridge Systematics, 1998; Forkenbrock and Weisbrod, 2001; MKI, 2003; Litman, 2004a; Hass-Klau, Crampton and Benjari, 2004). These benefits are summarized below.

Transportation System Cost Savings and Efficiency Gains

As described earlier, by attracting discretionary travelers, increasing transit ridership, and providing a catalyst for more efficient land use, rail transit provides various cost savings and efficiency gains, including congestion reduction, road and parking cost savings, consumer savings, reduced crash damages, and improved public health. These economic savings and efficiency benefits filter through the economy as savings to consumers, businesses and governments, making a region more productive and competitive.

Shifting Consumer Expenditures

Expenditures on automobiles, fuel and roadway facilities provide relatively little regional economic activity because they are capital intensive and largely imported from other areas. A study using national input-output table data found that each 1% of regional travel shifted from automobile to public transit increases regional income about $2.9 million, resulting in 226 additional regional jobs (Miller, Robison & Lahr, 1999). These impacts are summarized in Table 7. As described earlier, Large Rail city residents spend $448 annually less on average per capita on transportation than Bus Only city residents despite their higher incomes and longer average commute distances, totaling $22.6 billion in savings. If each million dollars in consumer expenditures shifted from automobile expenses to general consumer expenditures provides an average of 8.6 jobs and $219,000 in regional income, as indicated in Table 6, rail transit provides a total of 194,114 additional jobs and $4.9 billion in additional regional income in those cities.

Table 7 **Regional Economic Impacts of $1 Million Expenditure**

Expenditure Category	Regional Income	Regional Jobs
Automobile Expenditures	$307,000	8.4
Non-automotive Consumer Expenditures	$526,000	17.0
Transit Expenditures	$1,200,000	62.2

This table shows economic impacts of consumer expenditures in Texas.

Agglomeration Efficiencies

Land use density and clustering tend to provide agglomeration benefits, which can reduce the costs of providing public services and increase productivity due to improved accessibility and network effects (Litman, 2003c). One published study found that doubling a county-level density index is associated with a 6% increase in state-level productivity (Haughwout, 2000). This suggests that transit improvements can help create land use patterns that increase regional productivity and economic development. Although these impacts are difficult to measure, they are likely to be large.

Increased Property Values

Transit oriented development tends to increase local property values due to improved accessibility and livability in that area (Eppli and Tu, 2000; Smith and Gihring, 2003). Transit stations often provide a catalyst for various neighborhood improvements such as urban redevelopment, historic preservation, improved pedestrian conditions and New Urbanist design practices. A portion of these property value gains may be economic transfers (property value increases in one area are offset by property value reductions at other locations), but increased property values resulting from agglomeration efficiencies, shifted consumer expenditures, transportation efficiency and community redevelopment are true economic gains that increase productivity. Many businesses prefer to locate near rail stations to improve access for employees and customers; some employers say that employees who commute by rail are more productive since they avoid the stress and uncertainty of driving on congested roads. Table 8 summarizes property value increases measured near rail transit stations in various European and North American cities.

Table 8 **Rail Station Proximity Impacts on Property Values** (Hass-Klau, Cramption and Benjari, 2004)

City	Factor	Difference
Newcastle upon Tyne	House prices	+20%
Greater Manchester	Not stated	+10%
Portland	House prices	+10%
Portland Gresham	Residential rent	>5%
Strasbourg	Residential rent	+7%
Strasbourg	Office rent	+10-15%
Rouen	Rent and houses	+10%
Hannover	Residential rent	+5%
Freiburg	Residential rent	+3%
Freiburg	Office rent	+15-20%
Montpellier	Property values	Positive, no figure given
Orléans	Apartment rents	None-initially negative due to noise
Nantes	Not stated	Small increase
Nantes	Commercial property	Higher values
Saarbrűcken	Not stated	None-initially negative due to noise
Bremen	Office rents	+50% in most cases

This table summarizes how property values are affected by proximity to rail stations in various cities.

Community Redevelopment

Current development patterns tend to abandon older neighborhoods as new communities are built at the urban fringe. This tends to be inefficient in terms of infrastructure (roads, schools and other facilities in urban areas are underused while new facilities must be built in suburban areas) and in terms of social capital (many older neighborhoods have unique cultures, traditions and human relationships). This results, in part, from growing automobile traffic through older neighborhoods caused by urban fringe residents. Rail transit can provide a catalyst for urban redevelopment and help reduce automobile traffic volumes through urban areas. A unique transit service can be a popular tourist activity, help create community identity, which stimulates economic development.

Other Potential Benefits

Transit in general, and rail transit in particular, can provide important but difficult to measure benefits (Forkenbrock and Weisbrod, 2001). These are described briefly below.

Improved Accessibility For Non-Drivers

Automobile-dependent transport and land use patterns disadvantages non-drivers. It also imposes costs on motorists, who are forced to chauffeur non-driving family members and friends. Transit improvements and transit oriented development increase mobility and accessibility options for non-drivers. Since non-drivers tend to be physically, economically and socially disadvantaged compared with drivers, this increases equity, in addition to reducing costs and increasing economic productivity.

Avoided Chauffeuring

Chauffeuring refers to additional automobile travel specifically to carry a passenger. It excludes *ridesharing*, which means additional passengers in a vehicle that would be making a trip anyway. Some motorists spend a significant amount of time chauffeuring children to school and sports activities, family members to jobs, and elderly relatives on errands. Such trips can be particularly inefficient if they require drivers to make an empty return trip, so a five-mile passenger trip produces ten miles of total vehicle travel. Drivers sometimes enjoy chauffeuring, for example, when it gives busy family members or friends time to visit. However, chauffeuring can be an undesirable burden, for example, when it conflicts with other important activities. Quality transit service and transit oriented development allows drivers to avoid undesirable chauffeuring trips.

Option Value

Transit services provide *option value*, referring to the value people place on having a service available even if they do not currently use it (ECONorthwest and PBQD, 2002). Transit provides critical transportation services during personal and community-wide emergencies, such as when a personal vehicle has a mechanical failure, or a disaster limits automobile travel.

Community Livability

Community Livability refers to the environmental and social quality of an area as perceived by residents, employees, customers and visitors. Rail transit and transit-oriented development can help improve community livability in several ways, including urban redevelopment, reduced vehicle traffic, reduced air and noise pollution, improved pedestrian facilities, and greater flexibility in parking requirements and street design. This provides direct benefits to residents, increases property values and can increase retail and tourist activity in an area.

Improved Public Health

Many people lead overly-sedentary lifestyles, which causes various health problems. Increased walking is one of the most popular and effective way to increase physical activity among otherwise sedentary people. To the degree that transit trips involve walking or cycling links, and transit oriented development improves walking and cycling conditions, it can improve public health.

Comparing Benefits and Costs

Table 9 summarizes U.S. transit service expenditures and revenues. Rail subsidies (operating and capital expenses minus fare revenues) totaled $12.5 billion in 2002, averaging about $140 per capita when divided among the 90 million residents of cities with rail transit systems, compared with $13.8 billion bus transit subsides, which averages about $50 per capita when divided among 278 million U.S. residents. This indicates that the incremental cost of rail transit is about $90 annually per capita.

Table 9 **U.S. Transit Expenses and Revenues By Mode** (APTA, 2002)

	Bus	Trolley Bus	Demand Response	*Total Bus*	Heavy Rail	Commuter Rail	Light Rail	*Rail Total*
Capital Expenses (m)	$3,028	$188	$173	*$3,389*	$4,564	$2,371	$1,723	*$8,659*
Operating Expenses (m)	$12,586	$187	$1,636	*$14,408*	$4,268	$2,995	$778	*$8,041*
Total Expenses (m)	$15,613	$374	$1,809	*$17,797*	$8,832	$5,366	$2,502	*$16,699*
Fare Revenues (m)	$3,731	$60	$185	*$3,976*	$2,493	$1,449	$226	*$4,167*
Subsidy (Total Exp. - Fares)	$11,882	$315	$1,624	***$13,821***	$6,339	$3,917	$2,276	***$12,532***
Percent Subsidy	76%	84%	90%	*83%*	72%	73%	91%	*79%*

m=million

This compares with $67.7 billon in estimated monetized (measuring in monetary units) benefits identified in this study, as summarized in Table 10. This indicates that, considering just impacts suitable for monetization, economic benefits greatly exceed subsidies. Rail transit provides additional benefits unsuited to monetization, including economic development, improved mobility for non-drivers, community livability and improved public health. People who do not currently use rail transit benefit from reduced traffic and parking congestion, and other benefits dispersed through the economy.

Table 10 **Rail Transit Monetized Benefits**

Cost Savings	Billions
Congestion cost savings	$19.4
Consumer transportation cost savings	$22.6
Roadway Cost Savings	$8.0
Destination Parking Cost Savings	$7.3
Residential Parking Cost Savings	$4.8
Accident cost savings	$5.6
Totals	*$67.7*

Other researchers using comprehensive analysis find similar results. Nelson, et al (2006) used a regional transport model to estimate the benefits of the local transit system to transit users and the congestion-reduction benefits to motorists. They found that rail transit generates congestion-reduction benefits that exceed rail subsidies, the combined benefits of rail and bus transit easily exceed local transit subsidies generally, and the lowest-income group receives a disproportionately low share of the transit benefits, both in absolute terms and as a share of total income.

Rail Versus Bus Transit

There is considerable debate over the relative merits of bus and rail transit (Hass-Klau, et al., 2003; Pascall, 2001; GAO, 2001; Warren and Ryan, 2001; Thompson and Matoff, 2003; Balaker, 2004; Litman, 2004a; Henry and Litman, 2006). Some key issues are discussed here.

Rail transit tends to provide better service quality that attracts more riders, particularly discretionary users (Tennyson, 1988; Pratt, 1999; FTA, 2002; Currie, 2005). For example, a free bus line to downtown Tacoma, Washington attracted less than 500 daily riders, but when it was replaced with a light rail line, ridership increased to more than 2,400 a day. Rail can carry more passengers per vehicle which reduces labor costs, requires less land per peak passenger-trip, and causes less noise and air pollution compared with diesel buses. As a result, rail is more suitable for high-density areas. Rail transit is considered a prestige service that gains more public support, and provides a catalyst for urban redevelopment and more compact, multi-modal development patterns. Voters are often more willing to support funding for rail than for bus service. Transit-oriented land use patterns can increase property values and economic productivity by improving accessibility, reducing costs, improving livability and providing economies of agglomeration. In some cases, increased property values offset most or all transit subsidy costs. This does not generally occur with bus service.

A study by Schumann (2005) compares transit system performance in two similar size cities. The Sacramento Regional Transit District (www.sacrt.com) began building a Light Rail Transit system in 1985, while the Central Ohio Transit Authority (www.cota.com) Columbus failed in its efforts establish a similar system in Columbus, Ohio and so only offers bus transit. During the following 17 years, transit service and ridership increased significantly in Sacramento, but declined in Columbus, while operating costs per passenger-mile increased much more in Columbus than in Sacramento, as indicated in the table below.

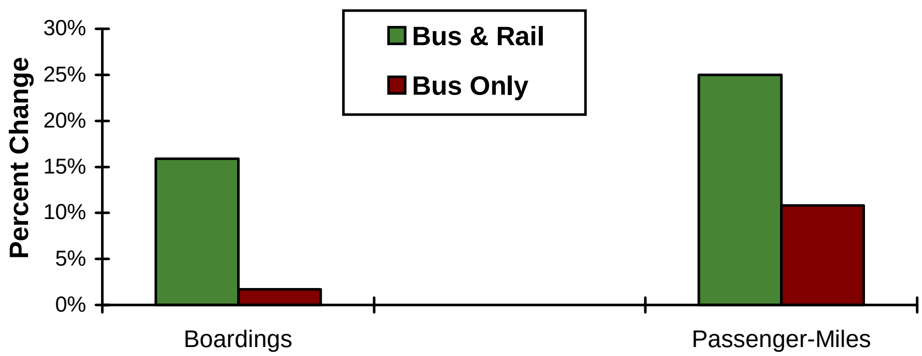
Table 11 **Columbus and Sacramento Transit Performance** (Schumann, 2005)

	1985			2002			Change	
	CO	SA	SA/CO	CO	SA	SA/CO	CO	SA
County Population (000)	*914*	*903*	*99%*	*1,084*	*1,302*	*120%*	*19%*	*44%*
Unlinked trips (000)	25,889	16,051	62%	16,246	26,610	164%	-37%	66%
Trips per capita	28.3	17.8	63%	15.0	20.4	136%	-47%	15%
Passenger miles (000)	121,408	93,473	77%	66,760	119,008	178%	-45%	27%
Passenger miles per capita	132.8	103.5	78%	61.6	91.4	148%	-54%	-12%
Transit vehicles	343	217	63%	298	250	84%	-13	15
Revenue vehicle miles	9,098	8,569	94	8,994	9,866	110%	-1%	15%
Operating expenses ($000)	$33,310	$25,681	77%	$62,877	$82,477	131%	89%	221%
Constant operating expenses (2002 $000)	$55,694	$42,939	77%	$62,877	$82,477	131%	113%	192%
Constant operating expenses per passenger-mile 2002$	$0.46	$0.46	100%	$0.94	$0.69	74%	205%	151%

CO = Columbus; SA = Sacramento; SA/CO = Sacramento/Columbus; 1985 to 2002 consumer price index change = 1.672.

In addition, voters appear more willing to support dedicated funding for transit systems that include rail transit service. In 1988, a year after the first rail line began operations, Sacramento country voters approved a referendum which provided sales tax funding to operate and expand the transit system. The article's author argues that Sacramento's first rail "starter" line gained public support for continual transit service improvements. Out of four Columbus area transit funding referenda between 1986 and 1995, only one passed. As a result of funding shortfalls the transit system has raised fares and reduced service, which helps explain the decline in transit ridership. The author argues that, had Columbus had a rail line in the 1980s there would probably have been more support for public transit funding, leading to a more attractive system and higher ridership now.

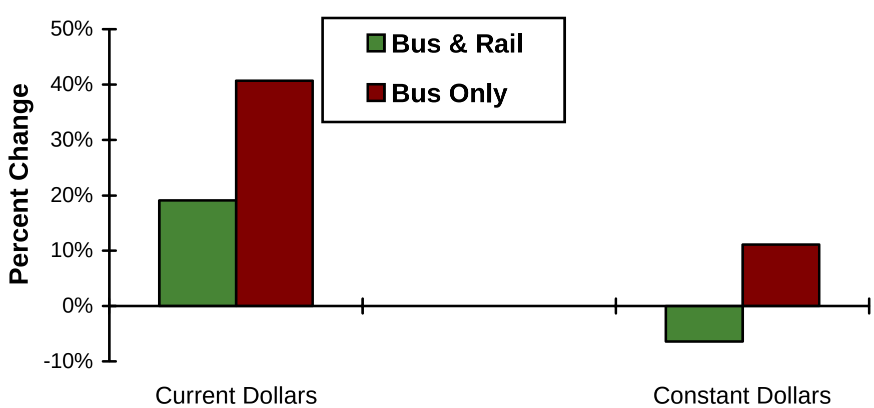
Figure 28 **Transit Ridership Changes – 1996 to 2003** (Henry and Litman, 2006)



Between 1996 and 2003 total transit use increased much faster in cities that have new or expanded rail service than in cities that only expanded bus service.

Henry and Litman (2006) used U.S. Federal Transit Administration data to compare transit system performance in U.S. urban areas that expanded rail systems with those that only expanded bus systems. The analysis indicates that cities which expanded rail systems significantly outperformed cities that only expanded bus systems in terms of ridership and operating cost efficiency, as summarized in figures 28 and 29.

Figure 29 **Change in Operating Costs Per Passenger-Mile** (Henry and Litman, 2006)



Between 1996 and 2003 real operating costs per passenger-mile declined in cities that have new or expanded rail service, but increased in cities that only expanded bus service.

In a detailed analysis Bruun (2005) found that in a typical case, both Light Rail Transit (LRT) and Bus Rapid Transit (BRT) have lower operating costs per passenger-space-kilometer during base periods than regular buses. For trunk line capacities below about 1,600 spaces-per-hour, BRT tends to be cheapest, while above 2,000 spaces-per-hour BRT headways become so short that traffic signal priority becomes ineffective, reducing service efficiency and increasing unit costs. The marginal cost of adding off-peak service is lowest for LRT, higher for BRT, and highest for regular buses.

Key differences between bus and rail transit are summarized on the next page. Each is most appropriate in particular situations. Bus is best serving areas with more dispersed destinations and lower demand. Rail is best serving corridors where destinations are concentrated, such as large commercial centers and mixed-use urban villages, or as a catalyst to create more accessible, multi-modal communities. Rail tends to attract more riders within a given area, but buses can cover larger areas. Both become more efficient and effective at achieving planning objectives if implemented with supportive policies that improve service quality, create supportive land use patterns and encourage ridership.

Bus Transit

Flexibility. Bus routes can change and expand when needed. For example, routes can change if a roadway is closed, or if destinations or demand changes.

Requires no special facilities. Buses can use existing roadways, and general traffic lanes can be converted into a busway.

More suitable for dispersed land use, and so can serve a greater rider catchment area.

Several routes can converge onto one busway, reducing the need for transfers. For example, buses that start at several suburban communities can all use a busway to a city center.

Lower capital costs.

Is used more by people who are transit dependent, so bus service improvements provide greater equity benefits.

Rail Transit

Greater demand. Rail tends to attract more discretionary riders than buses.

Greater comfort, including larger seats with more legroom, more space per passenger, and smother and quieter ride.

More voter support for rail than for bus improvements.

Greater maximum capacity. Rail requires less space and is more cost effective on high volume routes.

Greater travel speed and reliability, where rail transit is grade separated.

More positive land use impacts. Rail tends to be a catalyst for more accessible development patterns.

Increased property values near transit stations.

Less air and noise pollution, particularly if electric powered.

Rails stations tend to be more pleasant than bus stations, so rail is more appropriate where many transit vehicles congregate.

Rail transit can be compared to a luxury vehicle: it costs more initially but provides higher quality service and greater long-run value. As consumers become wealthier and accustomed to higher quality goods it is reasonable that they should demand features such as more leg-room, comfortable seats, smoother and quieter ride (and therefore better ability to read, converse, and rest), and greater travel speed associated with grade-separated transit. The preference of rail over bus can be considered an expression of consumer sovereignty, that is, people’s willingness to pay extra for the amenities they prefer.

Hiawatha Ridership exceeds Projections
Laurie Blake, "Light-Rail Ridership: A Love Story," *Minneapolis Star Tribune* (*www.startribune.com/stories/462/5724628.html*), November 14, 2005

When his carpool collapses for a day, John Healy has no qualms about riding light rail to work in downtown Minneapolis. "It seems a little more predictable and regular than the bus," he said...there is always another one coming." Healy is a new breed of transit rider – willing to take trains, but rarely, if ever, climbing aboard a bus. A 2004 survey found that 40% of Hiawatha's riders are like Healy – not bus riders before train service began. This preference for rail largely explains why the Hiawatha ridership is exceeding projections. Preconstruction predictions did not factor in positive attitudes toward the train. The Hiawatha ridership is 65% higher than predicted. In October, an estimated 742,000 riders used the line.

Rail's smooth ride and consistent schedule make it appealing to riders who would not consider the bus. The permanence of the track and the frequency of service make it easy to use without knowing a schedule. Within one year, light rail has emerged as the single busiest transit line in the metro area.

What Converts Like
The train made a transit convert of Jennifer Johnson of south Minneapolis, who said she and her husband never went downtown before the rail line opened. Now they go twice a month on the Hiawatha. "It's quick, it's clean, it's safe and little kids love the train," said Johnson, who had her child in tow. Flight attendant Cara Cobb, from Detroit, said it was the quick, direct rail service that prompted her to take the train from the Minneapolis-St. Paul Airport to the Mall of America during a break from work. "It was cheap and it was fun and we didn't have to wait long," she said. Had she ever taken a bus to the mall? Cobb shrugged. "I don't know where you get a bus at the airport."

Burnsville retiree Warren Nordley drove to Bloomington to catch the train to a University of Minnesota class. "I personally enjoy it," he said. "I feel it is a much more pleasant way to go than the bus. The big open windows – it's just a more pleasant feeling. And you are totally immune to the traffic." Nordley said he believes that men in general find the bus "beneath their dignity – it's just not classy enough." As a transit advocate, he prefers the train, but "either bus or train are far superior to driving your car."

Repercussions for the Future
The Metropolitan Council based its rail-rider predictions on bus-rider behavior. Wary of overstated ridership, the FTA discouraged even a 25% padding for rail preference, said Natalio Diaz, Council transportation planning director. "Now we have real numbers from observed behavior," Diaz said. "About 40% of the riders are people who were not using the bus. That is a huge amount."

Officials have spent more than a year correcting the metro area's forecasting methods to better reflect rail's appeal. This change could be important for ridership predictions on a proposed central corridor rail line along University Avenue linking St. Paul and Minneapolis. An upcoming environmental impact statement will compare the pros and cons of a rail line with bus rapid transit. Ridership will be central to that comparison and a key part of the choice between rail or bus, Diaz said.

Evaluating Rail Transit Criticism

This section evaluates some criticisms of rail transit. More detailed analysis is available in the companion document "Evaluating Rail Transit Criticism" (www.vtpi.org/railcrit.pdf) and CFTE (2005).

Rail transit is not appropriate in every situation, and even the best transit program can still be improved. Rail transit supporters should therefore welcome legitimate criticism to help identify possible problems and opportunities for improvement. However, some types of criticism are not helpful, because they misrepresent issues and reflect inaccurate analysis. It is therefore helpful to examine and evaluate rail transit criticisms to identify legitimate issues and concerns, and to recognize errors and misrepresentations.

A good research document provides readers with the information they need to make an informed assessment, including an overview of issues and information sources, discussion of various perspectives and evaluation methods, and information that both supports and contradicts (if any exists) the authors conclusions (Litman, 2004b). Many transit studies do this, providing accurate and useful analysis.

But some critics provide inaccurate information and biased analysis intended to present rail transit in a negative light. They fail to use best practices for accurate transit evaluation. They ignoring other perspectives, and suppress data that contradict their arguments. These critics tend to consider a relatively limited set of transit impacts, as summarized in Table 12. As a result, they tend to understate the full benefits of transit.

Table 12 **Impacts Considered and Overlooked** (Litman, 2004a)

Usually Considered	Often Overlooked
Financial costs to governments Vehicle operating costs (fuel, tolls, tire wear) Travel time (reduced congestion) Per-mile crash risk Project construction environmental impacts	Downstream congestion impacts Impacts on non-motorized travel Parking costs Vehicle ownership costs (depreciation, insurance, etc.) Project construction traffic delays Impacts of generated traffic Indirect environmental impacts Strategic land use impacts Impacts on transportation diversity (particularly mobility for non-drivers) Equity impacts Per-capita crash risk Impacts on physical activity and public health

Older transportation evaluation models tended to focus on a limited set of impacts, which tends to undervalue transit services and improvements.

Specific examples of rail transit criticism are examined below.

"Great Rail Disasters" *(O'Toole, 2004)*

Great Rail Disasters argues that rail transit is ineffective at improving transportation system performance and wasteful. Other rail critics, such as Balaker (2004), have citied O'Toole's study heavily. *Great Rail Disasters* uses a thirteen-component index created by the author to evaluate rail transit system performance. This analysis framework appears to be carefully designed to portray rail transit in a negative way. The report contains several fundamental omissions and misrepresentations. Major errors include:

- Failing to differentiate between cities with relatively large, well-established rail systems and those with smaller and newer systems that cannot be expected to have significant impacts on regional transportation performance.
- 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.
- Evaluating congestion impacts based on "Travel Time Index" values. Of the various congestion indicators this is one of the least appropriate for evaluating grade-separated transit, since it only considers delays to road vehicles, ignoring benefits to people who shift to transit, and from vehicle traffic reductions due to more accessible land use.
- Failing to compare individual cities and national trends. During the time period used for analysis, from 1970 to 2000, transit ridership and mode split declined nationally, so a lower rate of decline could be considered successful compared with most other cities.
- Failing to account for additional factors that affect transportation and urban development conditions, such as city size, changes in population and employment.
- Ignoring and understating significant costs of automobile travel. 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 reference documents that reflect current best practices in transit evaluation, such as ECONorthwest and PBQD (2002) or Litman (2004) or provide any information showing alternative perspectives.

Great Rail Disasters' bias is revealed in its analysis of Portland, Oregon. According to many of its own indicators Portland's rail system is successful, with increasing transit ridership and commute mode split. Still, O'Toole concludes that Portland's rail system is harmful because it involves transit-oriented development, which he opposes on the grounds that it is harmful to consumers. Yet, there is plenty of evidence that many consumers want to live in transit-oriented communities.

"Light Rail Boon or Boondoggle" *(Castelazo and Garrett, 2004)*

An article by Molly D. Castelazo and Thomas A. Garrett ("Light Rail: Boon or Boondoggle" 2004) argues that light rail investments are inefficient. Their analysis contains several critical errors. They ignore many costs of automobile transportation, including roadway costs, consumer costs, downstream congestion, parking facility costs, accident costs and pollution impacts. They use *average* cost values that underestimate the actual costs of accommodating increased automobile traffic in dense urban areas. They claim that light rail is more costly than automobile or bus transport, based on a national cost value of 54.4¢ per passenger-mile for light rail, although the actual cost in St. Louis is just 27¢, which is lower than either automobile or bus costs. They claim that light rail only provides short-term congestion and pollution reduction benefits, which is untrue, and indicates that they are unfamiliar with the issues.

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. Only a small portion of transit subsidies could efficiently or equitably be shifted to any one of these objectives.
- Second, many transit riders cannot or should not drive. Subsidized cars would not solve their mobility problems, and would tend to increase higher-risk driving.
- Third, substituting car ownership for transit service is 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 than simply driving a car.
- 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 underestimate these costs. In footnote 3 they calculate that giving 7,700 vehicles to current rail users would only increase regional congestion by 0.5%. But rail users commute on the city's most congested corridors, so congestion impacts will be proportionately large. The Texas Transportation Institute calculates that St. Louis traffic congestion costs totaled $738 million in 2001. If 7,700 additional downtown automobile commuters increases congestion 2.5-5.0%, this represents $18 to $37 million in additional annual congestion costs.
- Fifth, there are substantial practical problems subsiding cars. 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 only use transit occasionally. As a result, it would be necessary to offer a much larger number of households a part-time car, with provisions that account for constant changes in their mobility needs and abilities. Like any subsidy program, it would face substantial administrative costs and require complex rules to determine who receives how much subsidy in a fair and effective way. 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.

"Urban Rail: Uses and Misuses" *(Cox, 2000)*

Wendell Cox is a frequent critic of rail transit. He makes the following claims in a policy statement titled *Urban Rail: Uses and Misuses*. Responses to his claims are in italics.

- Virtually no traffic congestion reduction has occurred as a result of building new urban rail systems.
  As this report shows, cities with well-established rail transit have substantially lower per capita traffic congestion delay than cities with smaller or no rail system. Cities with new or expanding rail transit systems often experience reductions in vehicle ownership and use along rail corridors, attributed to a combination of transit improvements and transit-oriented development (see box).

Transit Improvements Help Reduce Vehicle Ownership and Use (www.translink.bc.ca)
In 2004 the city of Vancouver recorded a small 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 selecting 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.
  As this study shows, rail provides unique benefits. Rail transit reduces per capita congestion delays, traffic fatalities, consumer costs, and transit operating costs, increases transit service cost recovery, and provide other benefits. This occurs because rail tends to attract more discretionary riders than buses, does not require the ability to drive like a private automobile, avoids congestion if grade separated, and helps increase land use accessibility.

- 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 people are moving back into cities, and 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 overlook significant costs, including the costs of roadway capacity and parking facilities at destinations, and the costs of increased traffic congestion, traffic accidents and pollution emissions. It also ignores the fact that many transit users cannot or should not drive, and other benefits of rail transit.

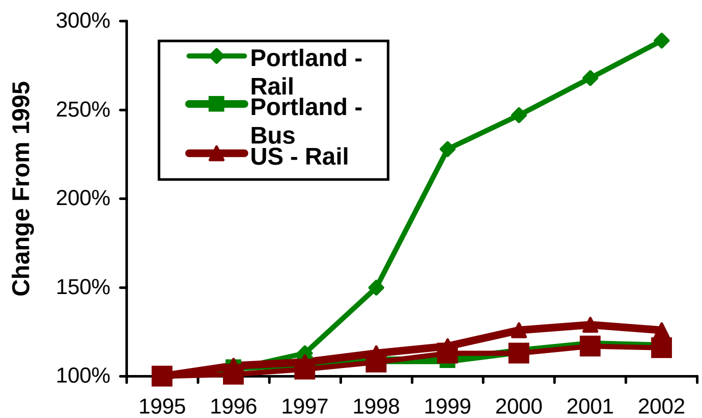
Possible Offsetting Factors

This study indicates that rail transit can provide various economic, social and environmental benefits, which in total significantly exceed rail system costs. It is worth investigating whether additional factors may offset these benefits, making rail transit harmful overall as some critics claim. Four possible factors are discussed below.

First, it is possible that these benefits are offset by disadvantages from reduced driving and transit oriented land use patterns. This would be true if automobile travel and sprawl were truly superior and universally preferred by consumers, but there is considerable evidence that at the margin (compared with current travel and land use patterns) many people would prefer to drive less, rely more on other modes, and live in more walkable, accessible communities with high transit service quality (Litman, 2003c; PPIC, 2002). This demand is likely to increase due to shifting demographics and consumer preferences (Reconnecting America, 2004).

A second possible counter-argument is that the superior performance of cities with rail transit is not *caused* by the rail service, but is simply an association resulting from other factors, such as these city's age or size. Some evidence supports this, since the cities with the best performance are old and large (New York, Chicago, Boston and Philadelphia. This argument implies that, although older cities with rail transit systems may have more efficient land use patterns that provide various benefits, it is impossible to create such land use patterns now, so new rail systems or expanding smaller rail systems may fail to achieve significant benefits, at least for many decades.

Figure 30 **U.S. and Portland Transit Travel Trends** (APTA & FHWA Data)



Portland rail transit ridership is growing much faster than national trends.

However, there are indications that new rail transit services can have desirable effects if implemented with supportive policies. For example, transit ridership has grown significantly in Portland in response to the city's rail system expansion, as indicated in Figure 30. Greater growth rates occur on particular corridors and in neighborhoods served by rail. This suggests that significant positive impacts are possible, and the debate can shift from *whether* new rail systems can achieve planning objectives, to *how* to best accomplish this (discussed in the next section).

Table 13 investigates the influence of city size on transportation system performance, using matched pair analysis of cities of comparable size with and without major rail transit systems. In nearly all cases, Large Rail performs better than Small Rail of comparable size (no large cities are classified as Bus Only). This indicates that rail transit systems really do provide performance benefits. The magnitude of these benefits suggests that rail is particularly important in large or growing cities.

Table 13 **Matched Pair Comparison Of Six Large U.S. Cities**

City	Category	Population	Transit Ridership	Congestion Costs	Traffic Fatalities	Consumer Costs	Cost Efficiency
			Per capita Pass.-Miles	Avg. Per-capita congestion costs	Deaths per 100,000 pop.	Per capita expenditures	Transit Cost Recovery
Chicago	Large Rail	8,307,904	447	515	7.9	$2,824	42%
Los Angeles	Small Rail	11,789,487	227	1005	7.8	$3,165	27%
Difference		*-42%*	*49%*	*-95%*	*2%*	*-12%*	*35%*
Philadelphia	Large Rail	5,149,079	720	330	9.3	$2,395	39%
Miami	Small Rail	4,919,036	136	625	13.3	$2,720	25%
Difference		*4%*	*81%*	*-89%*	*-43%*	*-14%*	*38%*
Boston	Large Rail	4,032,484	445	560	5.7	$2,897	31%
Dallas	Small Rail	4,145,659	113	710	12.0	$3,723	10%
Difference		*-3%*	*75%*	*-27%*	*-111%*	*-28%*	*67%*

This table compares the three largest Large Rail and the three largest Small Rail cities. Large Rail cities perform significantly better in nearly every category.

A third counter-argument is that bus transit could provide equal benefits as rail at a lower cost. This does not appear to be the case. Rail offers greater benefits due to its ability to attract more discretionary travelers and provide a catalyst for more efficient land use. Costs per passenger-mile are often lower for rail than bus transit, and unit costs for all forms of transit tend to be lower in cities with large, well-established rail systems. This indicates that in appropriate conditions, rail can be the more cost effective transit option.

Of course, there are plenty of situations in which rail transit is not cost effective due to inadequate demand, unusually high construction costs, or a lack of integration with transportation and land use policies, and other transit options should be selected. Rail transit projects should not be implemented simply for prestige or to obtain federal funds (Dittmar, 1997). Rail transit should only be implemented in urban areas that desire to become more multi-modal, and are willing to make an adequate commitment.

Although it is important to consider these arguments and perspectives when evaluating rail transit, there is no evidence that they eliminate rail transit benefits. On the contrary, even when these factors are taken into account, existing rail transit systems clearly provide significant net benefits, and new rail transit services can provide net benefits if they are properly planned, with features to optimize service quality, attract ridership and create supportive land use, such as those described in the next section.

Increasing Transit Benefits

Rail transit is sometimes criticized for poor service or low ridership. These concerns can often be addressed by implementing various strategies that improve service and increase ridership, many of which are justified on other grounds such as fairness, consumer benefits and cost savings. Examples are described below.

- *Service Improvements.* There are various ways to make rail transit faster, more convenient and more comfortable, and therefore more attractive to travelers.
- *Parking Management*. Parking management includes parking "cash out" (employees who receive free parking can choose cash or a transit subsidy instead), "unbundling" (renters only pay for the amount of parking they actually want), and more flexible parking requirements. These strategies often increase transit ridership by 10-30%.
- *Commute Trip Reduction (CTR) Programs.* CTR programs give commuters resources and incentives to reduce their automobile trips. They typically include financial incentives (parking cash out and transit allowances), transit promotion, parking management, flextime and guaranteed ride home services. Such programs typically reduce 10-40% automobile commute trip among affected employees, about a third of which shift to transit.
- *Nonmotorized Improvements.* Walking and cycling are important travel modes in their own right, and provide access to public transit. In many situations nonmotorized improvements may increase transit ridership 10-40% over what would otherwise occur.
- *Marketing and User Information*. Improved route schedules and maps, wayfinding information, webpages and marketing programs can often increase transit use by 10-25%.
- *Transit Oriented Development* (TOD) refers to residential and commercial areas designed to maximize access by public transit and nonmotorized modes. This means that development is clustered in an areas with high level of transit service, and good walking and cycling conditions. Residents of TODs typically use transit 25-50% more than residents of otherwise comparable communities.
- *Transit Fare Innovations.* Smart cards make transit use more convenient and allow transit agencies to offer new discounts, such as lower rates during off-peak periods, for special groups and for bulk ticket purchase.
- *Campus and School Transport Management Programs*. These programs improve travel options and reduce trips at schools and campus facilities. This often includes free or discounted transit passes to students and sometimes staff (called a "UPASS"). Such programs often increase transit ridership 30-100% among affected groups.
- *Road Pricing Reforms.* Congestion pricing, distance-based fees and Pay-As-You-Drive vehicle insurance are justified on equity and efficiency grounds, and can increase transit ridership.

Rail transit experiences significant economies of scale and network effects, that is, the larger the system, the more useful it is, the more ridership it attracts, the more it will be integrated into overall transportation and land use patterns, and so the more total benefits it will provide.

Conclusions

There is an important and interesting debate over the value of rail transit compared with other transportation options. To accurately assess rail transit benefits it is necessary to use a comprehensive analysis framework. This study applies the best current practices for evaluating rail transit benefits.

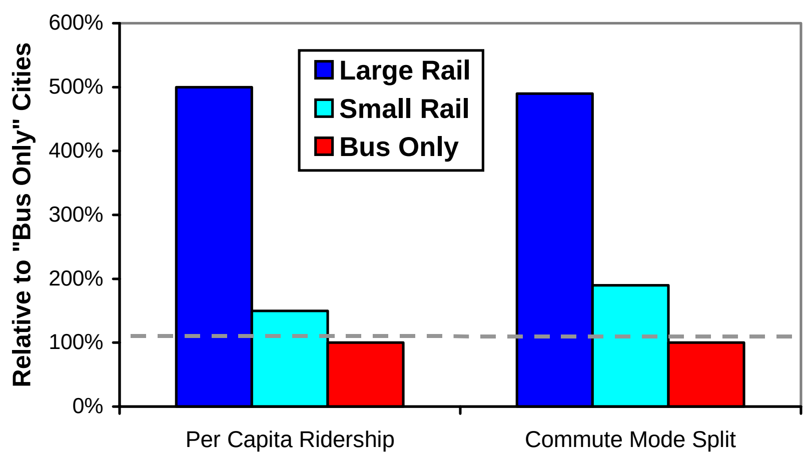
Table 14 **Transportation Performance Comparison**

	Definition	Large Rail	Small Rail	Bus Only
Ridership	Annual Passenger-Miles Per Capita	589	176	118
Commute Mode Split	Portion of Commute Trips By Transit	13.4%	5.2%	2.7%
Vehicle Mileage	Per Capita Average Vehicle-Mileage	7,548	8,679	9,506
Vehicle Ownership	Average Vehicles Per Capita	0.68	0.77	0.80
Traffic Safety	Traffic Deaths Per 100,000 Population	7.5	10.0	11.7
Congestion	Per Capita Annual Hours of Congestion Delay	28	24	20
Transport Expenditures	Avg. Annual Consumer Expenditures on Transport	$2,808	$3,350	$3,255
Portion of Income	Average Portion of Income Devoted to Transportation	12.0%	15.8%	14.9%
Operating Costs	Transit Operating Costs Per Passenger-Mile	$0.42	$0.63	$0.63
Transit Cost Recovery	Portion of Transit System Costs Covered By Fares	38%	23%	24%

This table summarizes the results of this study. "Large Rail" cities outperform "Small Rail" and "Bus Only" cities in all except congestion delays. When city size is taken into account, Large Rail cities outperform by this factor too.

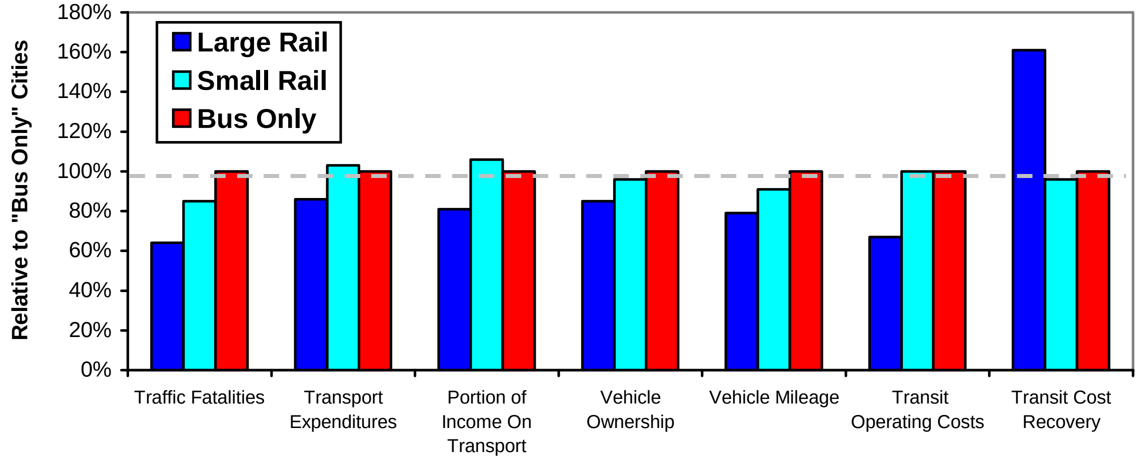
For this study, U.S. cities were divided into *Large Rail* (rail serves a significant portion of local travel), *Small Rail* (rail serves a minor portion of local travel), and *Bus Only* (city has no rail transit system). This analysis indicates that Large Rail cities have significantly superior transport system performance, as summarized in Table 14 and illustrated in figures 31 and 32.

Figure 31 **Transit Ridership and Commute Mode Split Comparison**



This graph shows the far higher rates of transit ridership and transit commute mode split in "Large Rail" cities. The dashed line at 100% indicates "Bus Only" city values.

Figure 32 **Transportation Performance Comparison**



This graph compares different categories of cities by various performance indicators. The dashed line at 100% indicates "Bus Only" city values.

Compared with Bus Only cities, Large Rail cities have:

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 887% higher the transit commute mode split (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 annual deaths per 100,000 residents).
- 14% lower per capita consumer transportation expenditures ($448 average annual savings), despite residents' higher incomes.
- 19% smaller portion of household budgets devoted to transportation (12.0% versus 14.9%).
- 21% lower per capita motor vehicle mileage (1,958 fewer annual miles).
- 33% lower transit operating costs per passenger-mile (42¢ versus 63¢).
- 58% higher transit service cost recovery (38% versus 24%).

These benefits result largely from rail's ability to create more accessible land use patterns and more diverse transport systems, which reduce per capita vehicle ownership and mileage. These additional benefits should be considered when evaluating rail transit.

Rail transit does have a cost. Rail transit requires about $12.5 billion annually in public subsidy, which averages about $90 additional dollars annually per rail transit city resident compared with Bus Only cities. However, these extra costs are offset several times over by economic benefits, including $19.4 billion in congestion costs savings, $8.0 billion in roadway cost savings, $12.1 billion in parking cost savings, $22.6 billion in consumer cost saving, and $5.6 billion in reduced crash damages.

From a household's perspective, rail transit provides a positive return on investment. Direct transportation cost savings average about $450 annually per capita. Rail transit tends to increase regional employment, business activity and productivity. It can contribute to urban redevelopment. Property values increase near rail stations. Quality transit improves mobility for non-drivers, reduces chauffeuring responsibilities for drivers, improves community livability and improves public health.

When critics conclude that rail transit is ineffective and wasteful, the failure is often in their analysis. Either from ignorance or intention, critics fail to use best practices for transit evaluation. Their statistical analysis tends to be flawed and biased. They ignore many benefits of rail transit, and understate the full costs of travel by other modes under the same conditions. They use inaccurate information. These errors and omissions violate basic evaluation principles and significantly distort results. Critics claim that rail transit support is limited to "Pork Lovers, Auto Haters, and Nostalgia Buffs." This is untrue. There are many reasons to favor rail development, and community support tends to increase after rail systems are established, indicating that users consider them successful.

This study indicates that rail transit is particularly important in large, growing cities. Large cities with well established rail systems are clearly advantaged in terms of congestion costs, consumer costs and traffic crash rates compared with cities that lack such systems. Cities with newer and smaller systems have not yet achieved the full impacts, but, if these rail systems continue to develop, their benefits should increase for decades, and so are a valuable legacy for the future.

Critics raise some valid issues. In particular, rail transit service has high fixed costs, and many benefits depend on reducing car travel, so it is important to attract riders, particularly travelers who would otherwise drive. This requires quality services that respond to user preferences, and are implemented with support strategies such as rider incentives and transit-oriented development. Rail systems experience significant economies of scale and network effects: the more complete the system the more it helps achieve transportation and land use planning objectives. For this reason, often the best response to criticism is to expand and increase support for rail systems.

This study compares bus and rail transit and discusses their appropriate applications. This is not a debate over which is best overall, since each has an important role to play in the nation's transportation system. It is up to individual communities to determine the combination of transit options that best meets its needs. This study does not suggest that rail service should be provided everywhere. However, on major corridors where road and parking facilities are costly to construct and transit demand is high, rail transit can be the most cost effective and overall beneficial way to improve urban transportation.

References

The analysis in this report is based on techniques and data sources described in "Evaluating Public Transit Benefits and Costs: Best Practices Guidebook" (Litman, 2004a), available at http://www.vtpi.org/tranben.pdf. Specific data and analysis are from the "Transit Performance Spreadsheet," available at www.vtpi.org/transit.xls.

APTA, *Off Track: Response of the American Public Transit Association and the Transit Industry to the UMTA Report "Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs*," American Public Transit Association (www.apta.com), 1990.

APTA, *Transit Statistics: Statistics By Transit Agency*, American Public Transit Association (www.apta.com/research/stats/agency/index.cfm), 2002.

Ted **Balaker**, *Past Performance Vs. Future Hopes: Will Urban Rail Improve Mobility In North Carolina?*, Policy Study 321, Reason Public Policy Foundation (www.rppi.org/ps321.pdf), 2004.

Nathaniel **Baum-Snow** and Matthew E. Kahn, *The Effects of Urban Rail Transit Expansions: Evidence from Sixteen Cities, 1970 to 2000*, Brookings Papers on Urban Affairs (www.econ.brown.edu/fac/Nathaniel_Baum-Snow/brook_final.pdf), 2005.

Antonio M. Bento, Maureen L. Cropper, Ahmed Mushfiq Mobarak and Katja Vinha, *The Impact of Urban Spatial Structure on Travel Demand in the United States*, World Bank Group Working Paper 2007, World Bank (http://econ.worldbank.org/files/24989_wps3007.pdf), 2003. Also published in *Review of Economics and Statistics* (http://mitpress.mit.edu), Vol. 87, Issue 3 - August 2005, pp. 466 – 478.

Beyond DC (www.beyonddc.com/features/compare.html) includes maps of U.S. cities with information on various features, including whether they have rail transit service.

BLS, *Consumer Expenditure Survey*, Bureau of Labor Statistics (www.bls.gov), 2003.

BTS, *National Transportation Statistics, 2003*, Bureau of Transportation Statistics (www.bts.gov/publications/national_transportation_statistics/2003), 2003

Cambridge Systematics, *Economic Impact Analysis of Transit Investments: Guidebook for Practioners*, Report 35, Transit Cooperative Research Program, TRB (www.trb.org), 1998.

Molly D. **Castelazo** and Thomas A. Garrett, "Light Rail: Boon or Boondoggle," *The Regional Economist* (www.stlouisfed.org/publications/re/2004/c/pages/light_rail.html), July 2004.

Census, *2002 American Community Survey*, U.S. Census Bureau (www.census.gov), 2002.

CFTE, *CFTE O'Toole Response*, Center for Transportation Excellence (www.cfte.org), 2003.

CFTE, *Building Communities Through Public Transportation: A Guide for Successful Transit Initiatives*, Center for Transportation Excellence, for the Public Transportation Partnership for Tomorrow (www.cfte.org/Building_Communities.pdf), 2005.

Comptroller and Auditor General, *Improving Public Transport in England Through Light Rail*, UK National Audit Office (www.nao.org.uk/pn/03-04/0304518.htm), April 2004.

Graham **Currie**, "The Demand Performance of Bus Rapid Transit," *Journal of Public Transportation*, Vol.8, No.1 (www.nctr.usf.edu/jpt/pdf/JPT%208-1%20Currie.pdf), 2005, pp. 41-55.

Hank **Dittmar**, *Is Rail Transit Right For Your Community? Asking the Right Questions; Measuring the Benefits*, Surface Transportation Policy Project (www.transact.org/report.asp), 1997.

Hank **Dittmar** and Gloria Ohland, *The New Transit Town: Best Practices In Transit-Oriented Development*, Island Press (www.islandpress.org), 2004.

Mark **Eppli** and Charles C. Tu, *Valuing the New Urbanism; The Impact of New Urbanism on Prices of Single-Family Homes*, Urban Land Institute (www.uli.org), 2000.

ECONorthwest and PBQD, *Estimating the Benefits and Costs of Public Transit Projects*, TCRP Report 78, (http://gulliver.trb.org/publications/tcrp/tcrp78/index.htm), TRB (www.trb.org), 2002.

FHWA, "Miles and Daily Vehicle-Miles of Travel," *Highway Statistics*, Table 71, Federal Highway Administration (www.fhwa.dot.gov/policy/ohim/hs02/re.htm), 2002.

David J. **Forkenbrock** and Glen E. Weisbrod, *Guidebook for Assessing the Social and Economic Effects of Transportation Projects*, NCHRP Report 456, Transportation Research Board (www.trb.org), 2001.

FTA, *Transit Economic Requirements Model (TERM)*, Federal Transit Administration (www.fta.dot.gov), 1998.

FTA, *National Transit Summaries and Trends*, Federal Transit Administration (www.ntdprogram.com), 2001.

FTA, *Transit Performance Monitoring System (TPMS) Results*, American Public Transit Association (www.apta.com) and the Federal Transit Administration (www.fta.dot.gov/transit_data_info/reports_publications/reports/16031_ENG_HTML.htm), 2002.

GAO, *Mass Transit; Bus Rapid Transit Shows Promise*, U.S. General Accounting Office, GAO-O1-984 (www.gao.gov/new.items/d01984.pdf), September 2001.

Thomas A. **Garrett** and Molly D. Castelazo, *Light Rail Transit in America: Policy Issues and Prospects for Economic Development*, Federal Reserve Bank of St. Louis (www.stlouisfed.org), 2004.

Carmen **Hass-Klau**, et al., *Bus Or Light Rail: Making The Right Choice*, Environment and Transport Planning, Brighton Press (Brighton), 2003.

Carmen **Hass-Klau**, Graham Crampton and Rabia Benjari, *Economic Impact of Light Rail: The Results Of 15 Urban Areas In France, Germany, UK and North America*, Environmental & Transport Planning (http://etphassklau.co.uk), 2004.

Andrew F. **Haughwout**, "The Paradox of Infrastructure Investment," *Brookings Review* (www.brookings.edu), Summer 2000, pp. 40-43.

Lyndon **Henry** and Todd Litman, *Evaluating New Start Transit Program Performance: Comparing Rail And Bus*, Victoria Transport Policy Institute (www.vtpi.org), 2006.

Daniel **Hess** and Paul Ong, *Traditional Neighborhoods and Auto Ownership*, Ralph & Goldy Lewis Center for Regional Policy Studies (www.sppsr.ucla.edu/lewis/WorkingPapers.html), 2001.

HLB, *Economic Study to Establish A Cost-Benefit Framework For The Evaluation of Various Types of Transit Investments*, Transport Canada (www.tc.gc.ca), 2002.

John **Holtzclaw**, *Does A Mile In A Car Equal A Mile On A Train? Exploring Public Transit's Effectiveness In Reducing Driving*, The Sierra Club, (www.sierraclub.org/sprawl/articles/reducedriving.asp), 2000.

ICCMA, *Why Smart Growth: A Primer*, International City/County Management Association, Smart Growth Network and USEPA (www.epa.gov/smartgrowth), 1998.

ITE, *Smart Growth Transportation Guidelines*, Smart Growth Task Force, Institute of Transportation Engineers (www.ite.org), 2003.

Jeffrey **Kenworthy** and Felix Laube, *Millennium Cities Database For Sustainable Transport*, Institute for Sustainability and Technology Policy, Distributed by the International Union of Public Transport (www.uitp.com), 2000. For additional analysis of this database see Newman and Kenworthy (1999), and Jeffrey Kenworthy and Felix Laube, *The Role Of Light Rail In Urban Transport Systems: Winning Back Cities From The Automobile*, presented to the 5th Light Rail Conference, UITP (www.uitp.com), 2000.

Kittleson & Associates, *Guidebook for Developing a Transit Performance-Measurement System*, TCRP Web Document 88 (http://gulliver.trb.org/publications/tcrp/tcrp_report_88/intro.pdf), Transit Cooperative Research Program, Transportation Research Board (www.trb.org), 2003.

David **Lewis** and Fred Laurence Williams, *Policy and Planning as Public Choice: Mass Transit in the United States*, Ashgate (Aldershot; www.ashgate.com), 1999.

Todd **Litman**, *Light Rail Economic Opportunity Study*, Island Tranformations (www.islandtransformations.org), 2002a.

Todd **Litman**, *Land Use Impact Costs of Transportation*, Victoria Transport Policy Institute (www.vtpi.org), 2002b.

Todd **Litman**, "Measuring Transportation: Traffic, Mobility and Accessibility," *ITE Journal* (www.ite.org), Vol. 73, No. 10, October 2003a, pp. 28-32, available at Victoria Transport Policy Institute website (www.vtpi.org).

Todd **Litman**, *Transportation Cost and Benefit Analysis Guidebook*, Victoria Transport Policy Institute (www.vtpi.org), 2003b.

Todd **Litman**, *Evaluating Criticism of Smart Growth*, Victoria Transport Policy Institute (www.vtpi.org), 2003c.

Todd **Litman**, *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*, VTPI (www.vtpi.org), 2004a.

Todd **Litman**, *Evaluating Research Quality: Guidelines for Scholarship*, Victoria Transport Policy Institute (www.vtpi.org), 2004b.

Todd **Litman**, *Evaluating Rail Transit Criticism*, Victoria Transport Policy Institute (www.vtpi.org), 2004c.

Todd **Litman**, *Safe Travels: Evaluating Mobility Management Safety Benefits*, Victoria Transport Policy Institute (www.vtpi.org), 2004d.

Todd **Litman**, *Land Use Impacts on Transportation*, Victoria Transport Policy Institute (www.vtpi.org), 2005.

LRN, *Study: Rail Transit May Slow Growth in Traffic Congestion*, Light Rail Progress, Light Rail Now (www.lightrailnow.org/facts/fa_00017.htm), 2001.

Jon **Miller**, Henry Robison & Michael Lahr, *Estimating Important Transportation-Related Regional Economic Relationships in Bexar County, Texas*, VIA Transit (www.viainfo.net), 1999.

MKI, *Transit Means Business – The Economic Case for Public Transit in Canada*, Canadian Urban Transit Association (www.cutaactu.ca), 2003.

Martin **Mogridge**, *Travel in Towns: Jam Yesterday, Jam today, and Jam Tomorrow?*, Macmillan, 1990.

John **Neff**, "Travel Distance Substitution Rates Between Automobile Users and Transit Patrons," *Papers and Proceedings of the Applied Geography Conferences, Vol. 19*, 1996.

Peter **Nelson**, Andrew Baglino, Winston Harrington, Elena Safirova and Abram Lipman, *Transit in Washington, D.C.: Current Benefits and Optimal Level of Provision*, Resources for the Future (www.rff.org/rff/Documents/RFF-DP-06-21.pdf), 2006.

Peter **Newman** and Jeffrey Kenworthy, *Sustainability and Cities; Overcoming Automobile Dependency*, Island Press (www.islandpress.org), 1999.

NPTS, *Summary of Travel Trends*, National Personal Transportation Survey, Bureau of Transportation Statistics, (http://npts.ornl.gov/npts/1995/Doc/trends_report.pdf), 1999.

Randal **O'Toole**, *Great Rail Disasters; The Impact Of Rail Transit On Urban Livability*, Reason Public Policy Institute (www.rppi.org), 2004. A nearly identical report was subsequently released by the Texas Public Policy Foundation (www.texaspolicy.com) in June 2004.

Glenn **Pascall**, *The Rail Transit Debate; An Assessment Of The Arguments*, Discovery Institute (www.discovery.org), 2001.

Rhonda **Phillips**, John Karachepone and Bruce Landis, *Multi-Modal Quality of Service Project*, Florida DOT (www.dot.state.fl.us/Planning/systems/sm/los/FinalMultiModal.pdf), 2001.

Bruce **Podobnik**, *The Social and Environmental Achievements of New Urbanism: Evidence from Orenco Station*, Department of Sociology Lewis and Clark College (www.lclark.edu/~podobnik/orenco02.pdf), 2002.

PPIC, *Special Survey on Land Use: Part of the Growth, Land Use and Environment Series*, Public Policy Institute of California (www.ppic.org), 2002.

Richard H. **Pratt**, *Traveler Response to Transportation System Changes, Interim Handbook*, TCRP Web Document 12 (www.trb.org), DOT-FH-11-9579, 1999.

Reconnecting America, *Hidden In Plain Sight: Capturing The Demand For Housing Near Transit*, Center for Transit-Oriented Development; Reconnecting America (www.reconnectingamerica.org/pdfs/Ctod_report.pdf) for the Federal Transit Administration (www.fta.dot.gov), 2004.

John L. **Renne**, *Transit-Oriented Development: Measuring Benefits, Analyzing Trends, And Evaluating Policy*, Dissertation, Rutgers State University, 2005.

Elizabeth **Ridlington** and Gigi Kellet, *Rail Transit Works: Light Rail Success Stories from Across the Country*, MaryPIRG Foundation (www.marypirg.org), 2003.

John **Schumann**, "Assessing Transit Changes in Columbus, Ohio, and Sacramento, California: Progress and Survival in Two State Capitals, 1995-2002," *Transportation Research Record 1930, Transit: Intermodal Transfer Facilities, Rail, Commuter Rail, Light Rail, and Major Activity Center Circulation Systems*, Transportation Research Board (www.trb.org), 2005, pp. 62-67.

Robert J. **Shapiro**, Kevin a. Hassett, and Frank S. Arnold, *Conserving Energy and Preserving the Environment: The Role of Public Transportation*, American Public Transportation Association (www.apta.com), 2002.

Jeffery J. **Smith** and Thomas A. Gihring, *Financing Transit Systems Through Value Capture: An Annotated Bibliography*, Geonomy Society (www.progress.org/geonomy), 2003, also available at the Victoria Transport Policy Institute (www.vtpi.org).

Steer Davies Gleave, *What Light Rail Can Do For Cities: A Review of the Evidence*, UK Passenger Transport Executive Committee (www.pteg.net), 2005.

Carl **Switzer**, *The Center Commons*, Portland State University research, presented at the Rail~volution Conference (www.railvolution.com), Atlanta, September 11-14, 2003.

TCRP, *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects*, Report 102, Transit Cooperative Research Program, Transportation Research Board (www.trb.org), 2004.

Edson L. **Tennyson**, "Impact on Transit Patronage of Cessation or Inauguration of Rail Service," *Transportation Research Record 1221*, Transportation Research Board (www.trb.org), 1988, pp. 59-78; available at www.publictransit.us/ptlibrary/supplydemand/TRB1221.pdf.

Greg L. **Thompson** and Tom G. Matoff, "Keeping Up with the Joneses: Planning for Transit in Decentralizing Regions," *Journal of the American Planning Association* Vol. 69, No. 3, Summer, 2003, pp. 296-312.

TRL, *The Demand for Public Transit: A Practical Guide*, Transportation Research Laboratory, Report TRL 593 (www.trl.co.uk), 2004; available at www.demandforpublictransport.co.uk.

TTI, *Urban Mobility Study*, Texas Transportation Institute (http://mobility.tamu.edu/ums), annual studies.

VTPI, *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org), 2004.

Vukan R. **Vuchic** (1999), *Transportation For Livable Cities*, Center for Urban Policy Research, CRPR Press (www.policy.rutgers.edu/cupr).

Vukan **Vuchic**, *Urban Transit: Operations, Planning and Economics*, John Wiley & Sons (www.wiley.com), 2005.

William **Warren** and Susan Ryan, "Metropolitan Rail Transit Expansion: Exploring A Route For Decision Making," *TR News 217* (www.trb.org), Nov.-Dec., 2001.

Paul M. **Weyrich** and William S. Lind, *Twelve Anti-Transit Myths: A Conservative Critique*, Free Congress Research and Education Foundation and the APTA (www.apta.com), 2001.

Clifford **Winston** and Ashley Langer, *The Effect of Government Highway Spending on Road Users' Congestion Costs*, Brookings Institute (www.brookings.edu), 2004.

Acknowledgements

Thanks to Tara Bartee, Glen Brand, Eric Bruun, Mike Davis, Dick Faulks, Phil Goodwin, Arthur Guzzetti, Lyndon Henry, John Holtzclaw, Tom Matoff, John Neff, John Schneider, Greg Thompson, Glen Weisbrod and Jeffrey Zupan for useful comments. Special thanks to Randal O'Toole and Wendell Cox who started me on this fascinating study. Any errors are, of course, my own.