VICTORIA Transport Policy INSTITUTE
EFFICIENCY • EQUITY • CLARITY

www.vtpi.org
Info@vtpi.org
250-360-1560

Evaluating Public Transit Criticism

Systematic Analysis of Political Attacks on High Quality Transit, and How Transportation Professionals Can Effectively Respond

27 November 2018

Todd Litman
Victoria Transport Policy Institute

Abstract

High quality public transit, such as urban rail and Bus Rapid Transit, and Transit Oriented Development (TOD), can provide many benefits, including direct benefits to users and indirect benefits to other members of society. There is evidence of growing consumer demand for these options. As a result, many communities are investing significant resources to improve transit services and encourage TOD. A small but vocal group of critics attack these efforts. Critics argue that transit service improvements attract few riders, provide few benefits, are not cost effective, are unfair to low-income residents and motorists, and will soon be replaced by self-driving cars. This report systematically evaluates these claims. Many of the critics' arguments are based on inaccurate, incomplete or biased information. This report describes appropriate responses to inaccurate criticisms. This should be of interest to transportation professionals, public transit advocates, and anybody interested in determining optimal investments in transit service improvements and TOD.

A shorter version of this report was published as:
"Evaluating Rail Transit Benefits: A Comment," *Transport Policy*, Vol. 14, No. 1 (www.elsevier.com/locate/tranpol), January 2007, pp. 94-97.

Contents

Executive Summary

An efficient and fair transportation system must be diverse to serve diverse demands: walking and cycling for local travel, public transit to provide basic mobility for non-drivers and efficient transport on major urban corridors, and automobile travel when it is truly most cost efficient. One way to increase transportation efficiency and equity is to improve public transit services and create Transit Oriented Development (TOD). This can provide large and diverse benefits, including direct benefits to users and indirect benefits to other community members.

This diversity of benefits is both a strength and a weakness. Critics exploit it to create doubt and conflict: they attack urban rail designed to attract drivers, and therefore reduce traffic problems, as being unfair to poor people; they attack bus services designed to provide basic mobility for non-drivers for being slow and ineffective at reducing traffic problems; and they attack Transit Oriented Development for the long time required to transform communities and achieve its ultimate goals. Clever critics assemble facts and examples that support these attacks, and use this to sow division among potential transit allies, for example, pitting anti-poverty advocates against urban rail, creating doubt that transit improvements reduce congestion and emissions, and encouraging urban residents to oppose TOD as a threat to their community. Like sleight-of-hand magicians, they misdirect the audience's attention from important to irrelevant issues.

However, this diversity is also an opportunity. Advocates can apply more comprehensive analysis showing that, although transit is not necessarily the best way to achieve any *single* goal, it is often very cost effective considering all benefits. Diverse benefits provide an opportunity to build coalitions in support of high quality transit and TOD based on shared goals.

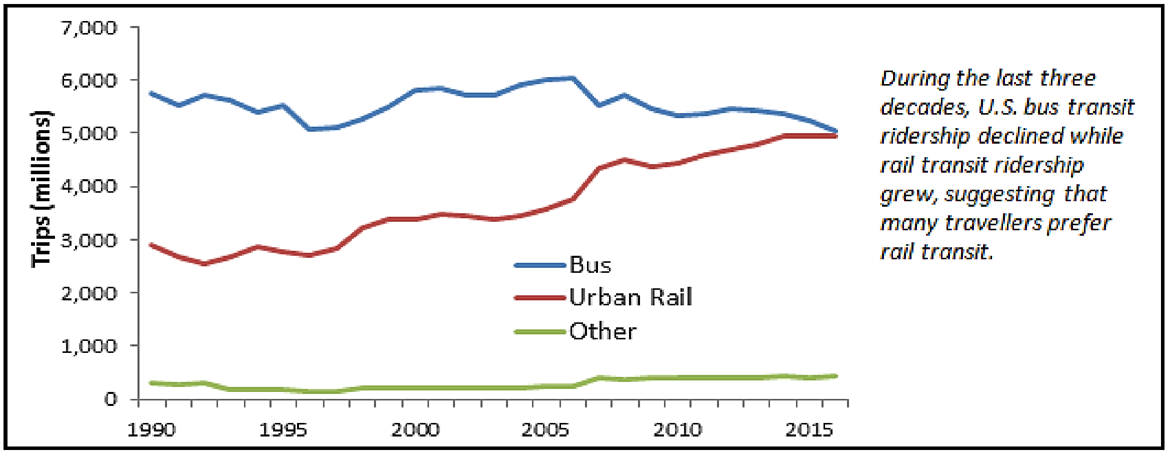
Although public transit only serves a small portion of total passenger-travel in most communities, many people can benefit from transit improvements because they or other household members currently use transit, or would use transit if it were more convenient and comfortable, or because they would benefit indirectly from reduced congestion, accident risk, pollution exposure or chauffeuring burdens, as described in the box below.

Measuring Transit Demand
Transit demand can be measured in different ways which affect the perceived value of transit improvements.

- *Portion of passenger-miles made by transit.* This is generally a small amount, and because it ignores leverage effects, represents a lower-bound estimate of vehicle travel reductions.
- *Transit mode share.* This is generally moderate, although often much larger on major urban corridors.
- *Portion of people who currently depend on public transit.* This is generally a small number which ignores latent demand (additional transit trips if service quality were better).
- *Portion of people who used public transit sometime during a month or year, or would like to use it if service were better.* This is generally a large number, often about half of residents.
- *Portion of households with members who currently use transit, at least occasionally, or would if service were better.* This is probably a majority of households.
- *Portion of people who could benefit either directly or indirectly from transit improvements*, because they or a household member currently uses transit or would use it if service were improved, or because it helps reduce their traffic and parking congestion, accident risk, pollution exposure or chauffeuring burdens. Most community members enjoy at least some of these benefits.

There is evidence of growing demand for high quality transit. Although few North Americans want to stop driving completely, surveys indicate that many would prefer to drive less and rely more on alternatives, provided they are convenient, comfortable and integrated. During the last two decades bus ridership declined while rail ridership increased (Figure ES-1), and ridership tends to increase with new rail lines. Real estate market research indicates that many households want to live in Transit Oriented Developments and will pay a premium for it.

Figure ES-1 **Public Transport Ridership Trends by Mode**



To serve these demands, communities must invest in high quality transit. Motorists who want more convenience and comfort can choose vehicles with better navigation systems and smoother rides, but transit service improvements require public investments. Serving demands for higher quality transit allows travellers to choose transit when it is the best option overall, considering all benefits and costs. High quality transit helps achieve social equity goals: it ensures that people who cannot, should not, or prefer not to drive receive their fair share of transportation investments, and provides affordable mobility options for low income travelers. By attracting travellers who would otherwise drive, high quality transit increases transit system efficiency, reducing traffic problems. The table below summarizes high quality transit benefits.

Table ES-1 **High Quality Transit and TOD Benefits**

Mobility Benefits	Efficiency Benefits	Land Use Impacts
Benefits from improving mobility options for non-drivers	Benefits from reduced automobile travel	Benefits from more compact, transit-oriented development
Improved user convenience and comfort Improved mobility and economic opportunity for non-drivers Equity objectives (benefits disadvantaged groups) Option value (value non-users place on having services available for possible future use)	Reduced traffic and parking congestion Road and parking facility cost savings Vehicle cost savings Reduced chauffeuring burdens Traffic safety Public fitness and health Energy savings & emission reductions	Improved accessibility Preserves openspace and reduces public infrastructure and service costs Agglomeration efficiencies increase economic productivity Increased local property values and tax revenues

Public transit can provide numerous direct and indirect benefits. Critics tend to undervalue many benefits.

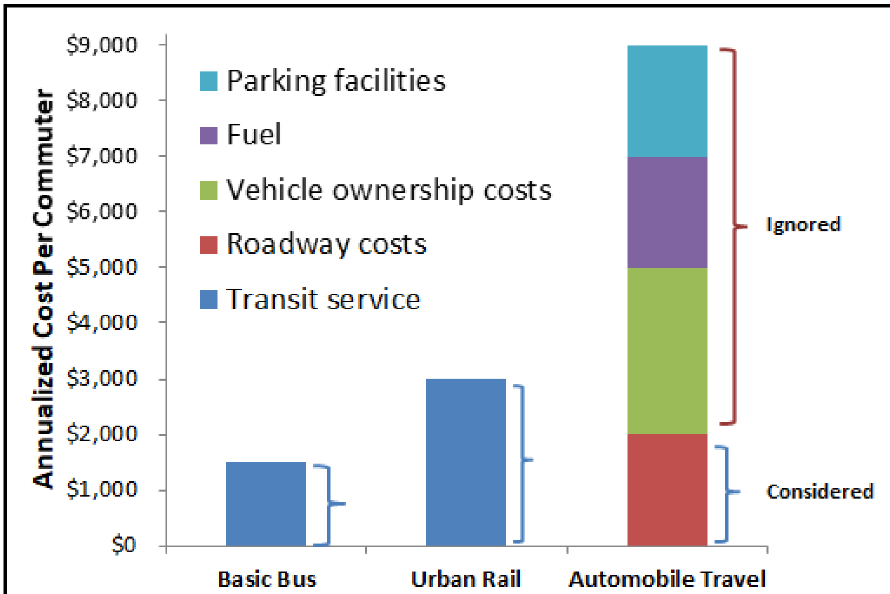
Like any major public policy decision, transit investments deserve comprehensive evaluation. Because they often require new funding, major transit projects generally face considerable scrutiny by policy makers, transportation agencies and voters, more than is usually required of road and parking facility investments that can draw on existing funds. Comprehensive evaluation of transit investments can be challenging because, although their costs are easy to measure, many benefits are indirect, non-market and long-term, and so can be difficult to predict with precision. However, a growing body of research and new analysis tools help improve our understanding of transit improvement impacts. Experience indicates that investments in high quality transit can provide high economic returns.

However, transit investments and Transit Oriented Developments are often attacked by a small but vocal group of critics. These critics tend to use biased and incomplete analysis to exaggerate costs and understate the benefits of high quality public transit, in the following ways.

First, critics try to make transit programs seem costly by reporting total spending over many years or decades, to create a very large number. For example, Cox and Kotkin (2017) report that U.S. transit subsidies exceeded $1 trillion since 1970, which seems large, but could also be reported as $22 billion annually, about 15% of roadway spending, or $88 annual per capita, or 25¢ per day per capita, about 2% of household motor vehicle expenditures, or a tiny amount compared with total spending on roads, parking facilities, vehicles and fuel for automobiles.

Second, critics often compare transit projects, which include rails or busways, stations and vehicles and sometimes operating expenses, with just roadway expansion costs, ignoring other automobile travel costs, including parking facilities, vehicles and fuel. Transit improvements are often cheaper overall than the total costs of accommodating more urban-peak automobile trips.

Figure ES-2 **Comparing Typical Bus, Rail and Automobile Urban Commute Costs**



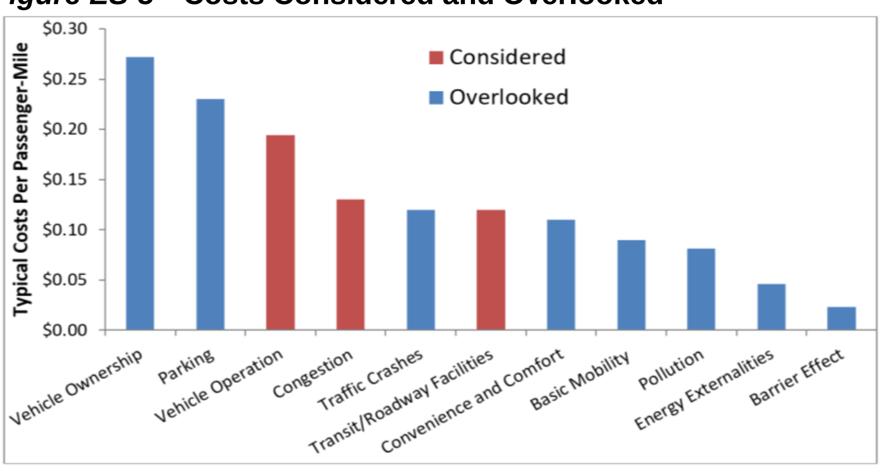
Conventional analysis often compares transit service costs, including rails or busways, stations, vehicles and sometimes operating expenses, with just roadway costs, ignoring other automobile travel costs including parking facilities, vehicles and fuel. For a typical urban commute, transit is often cheaper overall than the full costs of accommodating more automobile trips on the same corridor.

Third, critics ignore evidence that high quality transit and TOD increase transit ridership and reduce motor vehicle travel. They use regional travel data to claim that new transit projects are ineffective at changing travel patterns although that is an inappropriate geographic scale. Rail projects often significantly increase transit ridership and reduce auto travel where they operate, and so can reduce severe traffic and parking problems, but only serve a small portion of total areas and so have only modest regional mode share impacts. However, as transit networks expand, so do their impacts and benefits. Compared with urban regions that only have bus transit, those with large rail networks average (Litman 2005):

- 400% higher per capita transit ridership (589 versus 118 annual passenger-miles).
- 887% higher transit commute mode share (13.4% versus 2.7%).
- 36% lower per capita traffic fatalities (7.5 versus 11.7 annual deaths per 100,000 residents).
- 21% lower per capita motor vehicle mileage (1,958 fewer annual miles).
- 14% lower per capita consumer expenditures on transport ($448 average annual savings).
- 19% smaller portion of household budgets devoted to transport (12.0% versus 14.9%).
- 33% lower transit operating costs per passenger-mile (42¢ versus 63¢).
- 58% higher transit service cost recovery (38% versus 24%).
- Improved fitness and health (since most transit trips have walking or cycling links, so transit travelers are much more likely to achieve physical activity targets than motorists).
- More money circulating in local economies (since transit users spend significantly less on vehicles and fuel, and more on local goods and services).

Fourth, critics overlook or undervalue some of the largest benefits of high quality transit and TOD. For example, critics often evaluate transit projects based just on their traffic congestion or emission reduction impacts, ignoring many other benefits including increased transit system efficiency and cost recovery, improved user convenience and comfort, parking cost savings, vehicle ownership savings, affordability, improved mobility and economic opportunity for non-drivers, increased public safety and health, and local economic development.

Figure ES-3 **Costs Considered and Overlooked**



Critics often overlook significant benefits of high quality transit, including vehicle ownership and parking cost savings, reduced crash risk, improved user convenience and comfort, basic mobility for non-drivers, pollution emission reductions, energy conservation, and reduced barrier effect (reduced pedestrian delay).

Much of the critics' evidence is anecdotal: examples selected to support a conclusion, while contrary results are ignored. For example, critics attack new rail systems in Houston and Phoenix for failing to transform regional travel patterns, although those systems only serve a tiny share of total regional travel, but ignore larger and more integrated, and therefore more successful rail systems built in the Twin Cities, Sacramento, Seattle, Vancouver and Calgary which have significantly increased transit ridership and transport system performance. Similarly, critics often choose data from time periods when transit ridership declined but ignore other time periods that show more impacts and benefits from transit improvements. The table below summarizes common transit criticisms and appropriate responses that can be used by transportation professionals and transit advocates.

Table ES-2 Common Transit Criticisms and Responses

Criticisms	Appropriate Responses
Transit demand is declining.	Although demand is declining for lower-quality transit, ridership tends to increase with service quality, and is particularly high in Transit Oriented Developments. In most communities a significant portion of travellers cannot, should not or prefer not to drive, and so demand transit service and TOD.
Autonomous taxis will eliminate public transit demand	Optimists exaggerate the speed of autonomous vehicle development, its likely cost efficiency, and net benefits. Self-driving taxis may eventually offer affordable service in lower-density areas, but are likely to increase total vehicle travel and congestion problems unless cities apply efficient road pricing and other policies that favor shared vehicles, that is, public transportation.
Transit fails to attract new riders and reduce auto travel.	Critics fail to account for transit service quality and use inappropriate geographic scales. High quality transit and TOD significantly increase ridership and reduces automobile travel in affected areas.
High quality transit is very expensive.	Critics exaggerate transit costs. Transit expenses should be reported per capita and compared with the total costs of accommodating automobile travel under the same conditions.
Transit investments are not cost effective.	Critics undervalue many transit benefits. When all impacts are considered, high quality transit is often very cost effective.
Transit does not reduce congestion or air pollution.	Critics use incomplete and biased data. Good research indicates that high quality transit and TOD provide significant congestion and emission reductions.
Transit is slow and inefficient.	Slow travel speeds reflect lower quality transit. High quality transit is relatively fast and often time-competitive with driving. If high quality service is available travelers can choose the best option for each trip, considering all impacts.
Transit investments are unfair to motorists	Automobile travel is highly subsidized, particularly on dense urban corridors. Transit investments ensure that non-drivers receive a fair share of public investments. Motorists benefit from high quality transit that reduces congestion, accident risk and chauffeuring burdens.
Transit is subsidized, automobile travel is not	Critics misrepresent costs. Transit services are subsidized directly, automobile travel is subsidized indirectly by road and parking costs not borne directly by users, and other uncompensated external costs.
Rail transit harms poor people by reducing basic bus services	Poor people use and benefit from high quality transit. Rail and BRT often generate new transit funds and so do not necessarily reduce bus services.

Many common criticisms misrepresent key issues and can be challenged.

Critics use various analytic tricks to exaggerate transit costs and undervalue benefits:

- Measure transit ridership in areas with poor service quality, ignoring the greater ridership achieved by higher quality transit and Transit Oriented Development.
- Use inappropriate geographic scales, such as national or regional ridership trends, rather than comparing the ridership of areas with high and low service quality.
- Ignore leverage effects that high quality transit and TOD often have on vehicle ownership and use, and the large resulting benefits.
- Ignore significant transit benefits including parking cost savings, consumer savings and affordability, improved mobility for non-drivers, improved public safety and health, environmental protection, economic development, and strategic goal support.
- Ignore social equity goals and increased economic opportunity provided by high quality transit.
- Use biased evidence such as selected examples, outdated data, and non-representative surveys.
- Compare transit costs with just highway capital costs, ignoring other costs required by automobile travel including vehicles, fuel and parking facilities.
- Compare the costs of building urban rail lines with average roadway construction costs, ignoring the much higher costs of infrastructure in dense urban areas.
- Report total transit spending over a long period during times of rapid system expansion to produce large numbers that make transit seem expensive.
- Ignore research showing significant congestion and emission reductions from high quality transit.
- Ignore requirements for quality research such as independent peer review and reporting of funding sources and conflicts of interest.

This suggests that critics either do not understand how to perform comprehensive and objective transit benefit and cost analysis, or intentionally bias the analysis. Regardless, it is important that planning professionals and transit advocates understand these distortions and respond with more accurate and comprehensive information.

This report examines these issues. It discusses the principles for comprehensive and fair transit evaluation, examines various arguments made by transit critics, critiques specific examples of these criticisms, and describes ways to respond to inaccurate claims. Although previous studies have responded to transit criticisms, this is the most systematic and comprehensive. It should be useful to public officials, transportation professionals, transit advocates and concerned citizens.

Introduction

An efficient and fair transportation system must be diverse in order to serve diverse demands: safe walking and cycling for healthy neighborhood travel, efficient public transit to provide basic mobility for non-drivers and efficient transport on major urban corridors, and automobile travel when it is truly optimal, considering all benefits and costs. This requires multimodal planning which recognizes the unique and important roles played by different travel modes.

People typically devote 90 daily minutes to local travel, which represents 15-20% of their personal time (excluding sleeping and working), and they spend a similar portion of their household budgets on transport. As a result, the convenience, comfort and affordability of daily travel significantly affects our lives. As people become more affluent they tend to demand higher quality goods and services. Many motorists pay extra for vehicles with features such as advanced navigation systems, smoother rides, cup-holders and better sound systems. Similarly, many people want more convenient and comfortable alternatives to driving.

One of the most effective ways to serve this demand is to invest in high quality public transit, such as urban rail and Bus Rapid Transit (BRT), and to support Transit Oriented Development (TOD). This creates faster, more frequent, more comfortable and integrated transit services, and more compact, multimodal communities where residents tend to own fewer vehicles, drive less and rely more on alternative modes than they would in automobile-dependent areas. This can provide many benefits, including direct user benefits and indirect benefits to motorists.

There are debates concerning the optimal amount to invest in high quality transit: Should investments reflect current transit demand, goals for future transit ridership, benefit/cost analysis of transit projects, or service levels needed to ensure adequate mobility options for people who cannot, should not or prefer not to drive? Are large investments justified to correct for decades of transit underfunding? Those are good questions!

Because they often require new funding, major transit projects generally face considerable scrutiny by policy makers, transportation agencies and voters, more than is usually required of road and parking facility investments that can draw on existing funds. Comprehensive evaluation of transit investments can be challenging because many benefits are indirect, non-market and long-term, and so can be difficult to measure. However, a growing body of research and new analysis tools help improve our understanding of transit improvement impacts. Experience indicates that investments in high quality transit can provide high economic returns.

Efforts to improve transit are often attacked by a small but vocal group of critics who tend to use inaccurate arguments and biased evidence to undervalue public transit and TOD. People unfamiliar with these issues may find their arguments persuasive. It is up to transit professionals and advocates to identify the errors and omissions in critics' arguments.

This report examines these issues. It discusses the principles for comprehensive and fair transit evaluation, examines various arguments made by transit critics, critiques specific examples of these criticisms, and describes ways to respond to inaccurate claims. Although previous studies have responded to transit criticisms, this is the most systematic and comprehensive. It should be useful to public officials, transportation professionals, and transit advocates.

Principles for Comprehensive and Fair Analysis

This section discusses the analysis methods required for comprehensive evaluation of high quality public transit and Transit Oriented Development.

Recent publications by leading academic and professional organizations provide guidance of comprehensive and accurate analysis of public transit investments (DfT 2017; ECONorthwest and PBQD 2002; Ferrell 2015; HLB 2002; Gwee, Currie and Stanley 2011; Litman 2017; NACTO 2018; NZTA 2017; UITP 2009; Wallis, Lawrence and Douglas 2013). They recommend that evaluations:

- *Measure impacts on affect travellers and residents.* For example, rail projects should be evaluated based on how they affect travel on the corridor served, and TODs should be evaluated based on how they affect the travel activity of people who live and work in that area compared with similar groups living in more automobile-dependent areas.
- *Compares like-with-like.* For example, public transit costs should be compared with the full costs of accommodating automobile trips under the same conditions.
- *Consider all significant impacts.* Conventional transportation benefit/cost evaluations only consider a limited set of impacts. Table 1 identifies impacts generally considered in conventional analysis, and additional impacts that should be considered for comprehensive evaluation.

Table 1 **Scope of Impacts Considered** (Litman 2015)

Conventional Analysis	Comprehensive Analysis
	Downstream traffic impacts
	User comfort and convenience (e.g., by transit passenger)
	Affordability, including vehicle ownership costs
Public expenditures on facilities and services	Parking facility costs
Travel speed (congestion delays)	Mobility for non-drivers, and social equity impacts
Vehicle operating costs (fuel, tolls, tire wear)	Per capita crash risk
Per-mile crash rates	Per capita emissions
Per-mile emission rates	Public fitness and health
Road construction environmental impacts	Strategic development impacts

Conventional analysis considers a limited set of impacts and so is unsuitable for comparing different modes or evaluating planning decisions that affect vehicle ownership and use.

- Considers social equity impacts, including horizontal equity (fairness), which requires providing a fair share of public resources to travellers who cannot, should not, or prefer not to drive, and vertical equity which requires policies that provide basic mobility for physically, economically and socially disadvantaged people.
- Gives readers the information they need to make informed and critical judgement. This includes comprehensive literature reviews, descriptions of alternative perspectives and contrary evidence, discussion of possible omissions and biases, independent peer review, adequate references so others can understand and replicate results, declaration of funding sources and conflicts of interests, and respectful responses to legitimate criticisms.

Critics often violate these principles. Table 2 summarizes distortions critics use to undervalue and denigrate high quality transit, and appropriate responses for more accurate analysis.

Table 2 **Analysis Distortions and Appropriate Responses**

Analysis Distortions	Appropriate Responses
Ignore demands of travellers who cannot, should not or prefer not to drive. Measure transit demand based on ridership in areas with poor service quality.	Identify people who cannot, should not or prefer not to drive. Measure the demand for high quality public transit and Transit Oriented Development.
Evaluate high quality transit based on national or regional ridership trends.	Evaluating transit projects based on their travel impacts on affected travellers and areas.
Use inappropriate scale. For example, criticize relatively small rail systems for failing to transform regional transport systems.	Focusing on travel changes by affected travellers, such as increased ridership and reduced auto travel on corridors with high quality transit and TODs.
Ignore significant transit benefits such as parking cost savings, consumer savings and affordability, improved mobility for non-drivers, increased traffic safety and public health, environmental protection, economic development, and support for strategic goals.	Consider all significant benefits when evaluating transit benefit and comparing transit and automobile projects. Design transit improvements to maximize these benefits.
Ignore social equity goals and the increased economic opportunity provided by high quality transit and TOD.	Consider social equity benefits. Design transit improvements and TOD to maximize this benefit.
Use biased evidence such as selected examples, outdated data or non-representative surveys.	Present more appropriate evidence.
Ignore leverage effects that high quality transit and TOD have on vehicle ownership and use.	Account for the leverage effects and resulting benefits.
Compare transit costs with just highway costs, ignoring other costs required for automobile travel including vehicles, fuel and parking facilities.	Compare the costs of transit projects with the total costs of accommodating additional automobile travel under the same conditions.
Report total transit spending over a long period of system expansion.	Report annual costs per capita, and compare this with total spending on roads, parking and vehicles.
Ignore research showing significant congestion and emission reductions from high quality transit.	Use best current information concerning public transit congestion and emission reductions.
Evaluate transportation efficiency based mainly on travel speed and delay, ignoring other factors.	Account for user convenience and comfort, and other benefits provided by high quality transit.
Cherry pick examples, time periods and performance indicators that make high quality transit look bad.	Use more appropriate and comprehensive examples, time periods and indicators.

Critics use various tricks to underestimate the demand for high quality public transit, and to undervalue the benefits of serving this demand. This table summarizes appropriate responses to these inaccurate claims.

Common Criticisms

This section investigates various arguments often raised by critics.

There is Little Demand for Public Transit

Critics claim that, outside a few large cities, few people want to use public transit. This is untrue: surveys indicate that many people would like to rely more on public transit, provided it is convenient, comfortable and integrated, and transit ridership tends to increase significantly with improved service quality.

Transit demand can be measured in various ways to lead to various conclusions about the number of current and potential users, as indicated in the box below. Critics generally use narrow definitions, such as current ridership, rather than broader definitions such as the portion of travellers who would use high quality transit service if available, or the portion of households with at least one member who would use such services. Potential transit ridership is often much larger than current statistics indicate. In typical communities, 20-40% of travellers cannot, should not, or prefer not to drive due to age, ability, income, impairment, driver's licensure, or preferences. Improving public transit services ensures that these travellers receive a fair share of public investments, and provides basic mobility for physically, economically and socially disadvantaged people. Even people who do not currently use public transit can benefit from transit service improvements.

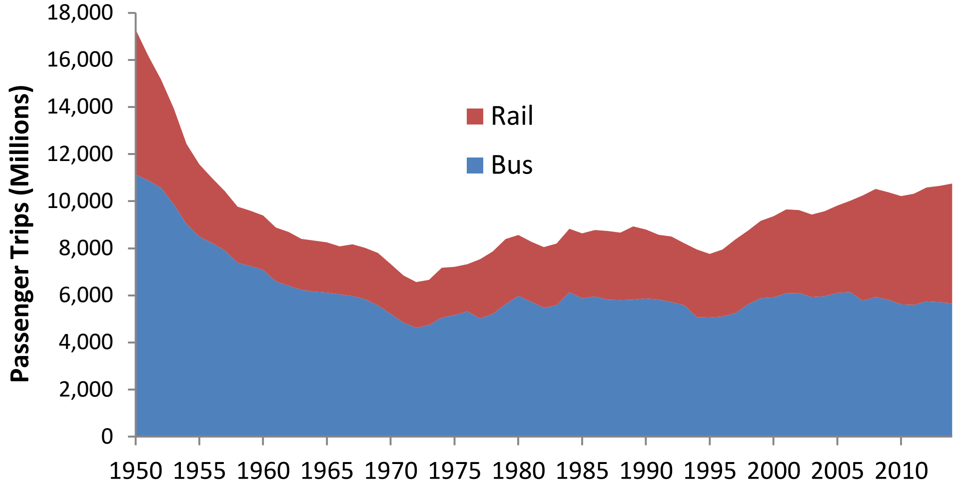
Measuring Transit Demand

Transit demand can be measured in different ways which affect the perceived value of transit improvements.

- Portion of total passenger-miles made by transit. This is generally a small amount, and because it ignores leverage effects, represents a lower-bound estimate of vehicle travel reductions.
- Portion of urban-peak trips or commute trips ("mode share"). This is generally a moderate portion of trips, and represents traffic congestion reduction benefits, but also overlooks leverage effects.
- Portion of people who currently depend on public transit. This is generally a small number which ignores latent demand (additional transit trips if service quality were better).
- Portion of people who used public transit sometime during a month or year, or would like to use it if service were better. This is generally a large number, probably about half of residents.
- Portion of households with members who currently use transit, at least occasionally, or would if service were better. This is probably a majority of households.
- Portion of people who could benefit either directly or indirectly from transit improvements, because they or a household member currently uses transit, would use transit if it were more convenient and comfortable, or because transit that attracts motorists would reduce their traffic congestion, parking problems, accident risk, pollution exposure or chauffeuring burdens. Although not everyone enjoys all of these benefits, most community members could enjoy at least some.

Where high quality transit exists (called *transit competitive corridors*) it often carries a significant portion of travel (Ehrenhalt 2009). Areas served by rail usually have much higher transit commute mode shares than those with lower quality transit (Evans and Pratt 2007; Demery and Setty 2005; Lane 2008), and total transit ridership usually increases as rail transit networks expand (CTS 2013; Freemark 2014a).

Figure 1 **U.S. Public Transit Ridership Trends** (APTA 2016)

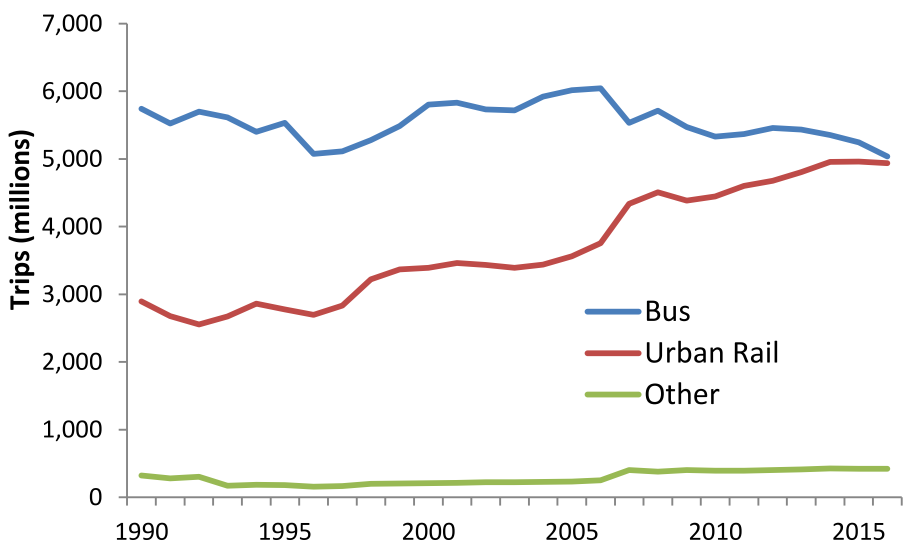


U.S. transit trips peaked during the 1940s, declined until the 1970s, after which bus ridership was approximately stagnant while rail ridership grew, indicating growing demand for high quality transit service.

Figure 1 illustrates U.S. transit ridership trends. Per capita transit ridership peaked during the 1940s, declined until the 1970s, after which bus ridership was stagnant but rail ridership grew. Critics argue that this shows that there is little demand for transit. A second explanation is that public policies created a self-fulfilling prophecy of increased highway investments, declining investments in transit, and automobile-oriented development, which reduced transit service quality and increased motor vehicle travel, forcing people to drive more than they want.

There is probably truth to both explanations. Certainly, many trips are best made by automobile, but there is good evidence that many travellers will choose transit over automobile travel for many trips if it is convenient and comfortable (Boarnet and Houston 2013; CNT 2013). This is indicated by the growth in rail travel, which tends to offer higher quality services, compared with bus transit, as illustrated below. This suggests that demand for rail is greater than for bus.

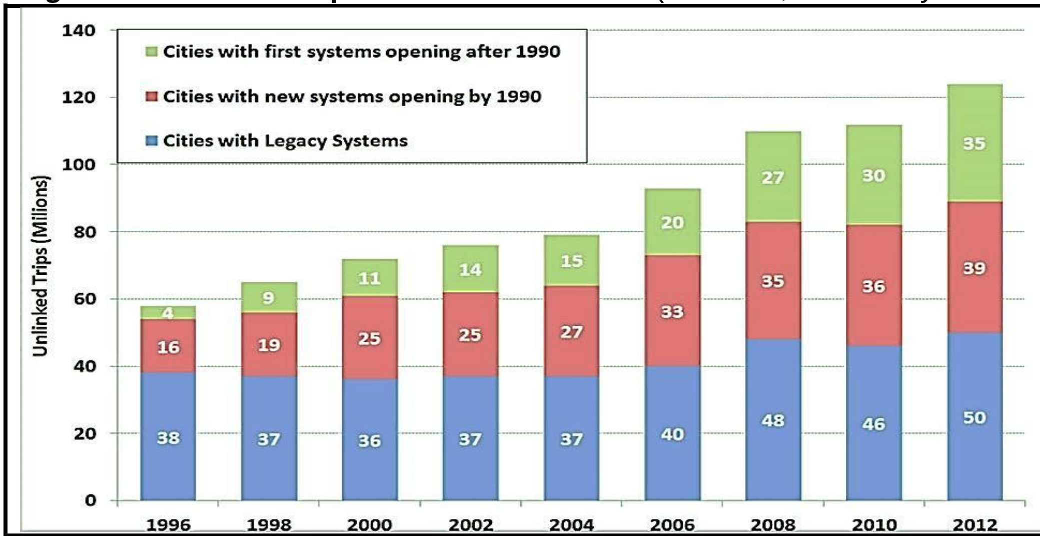
Figure 2 **Public Transport Ridership Trends by Mode** (APTA 2016)



During the last three decades, U.S. bus transit ridership declined while rail transit ridership grew, suggesting that many travellers prefer rail.

Transit ridership often increases substantially on corridors after new rail transit lines start operating (CTS 2013; Freemark 2014b). Of course, most new rail lines only carry a small portion of total regional travel, so their impacts on regional travel patterns are small, but as transit systems expand and stimulate Transit Oriented Development, travel impacts can be large. Cities with large, well-established rail transit systems have four times higher per capita transit ridership (589 versus 118 annual passenger-miles) and nearly ten time higher transit commute mode shares (13.4% versus 2.7%) as cities that only have bus systems (Litman 2005).

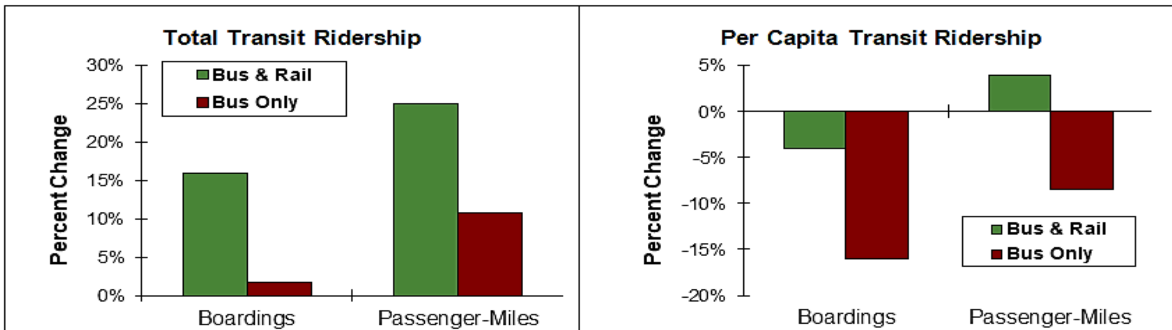
Figure 3 **Ridership Growth in U.S. Cities** (Newman, Kenworthy and Glazebrook 2013)



Cities generally experience significant ridership growth after developing high quality transit systems.

Critics point to examples of ridership declines in cities with urban rail systems, but the examples they choose, such as Houston and Phoenix have relatively small and poorly integrated rail networks. Cities with larger networks, such as Twin Cities, Sacramento, Seattle, Vancouver and Calgary, gained more ridership or experienced smaller losses than those with lower-quality transit (CTS 2013; Renne 2005). Henry and Litman (2006) found that U.S. urban areas that expanded rail systems between 1996 and 2003 had significantly more ridership growth than those that only expanded bus systems (Figure 4).

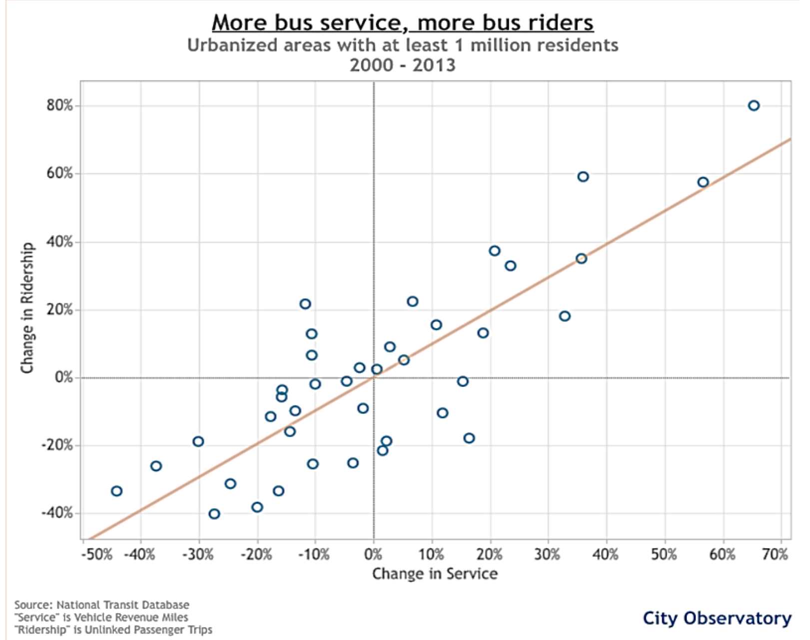
Figure 4 **Changes in Transit Ridership – 1996 to 2003** (Henry and Litman 2014)



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

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

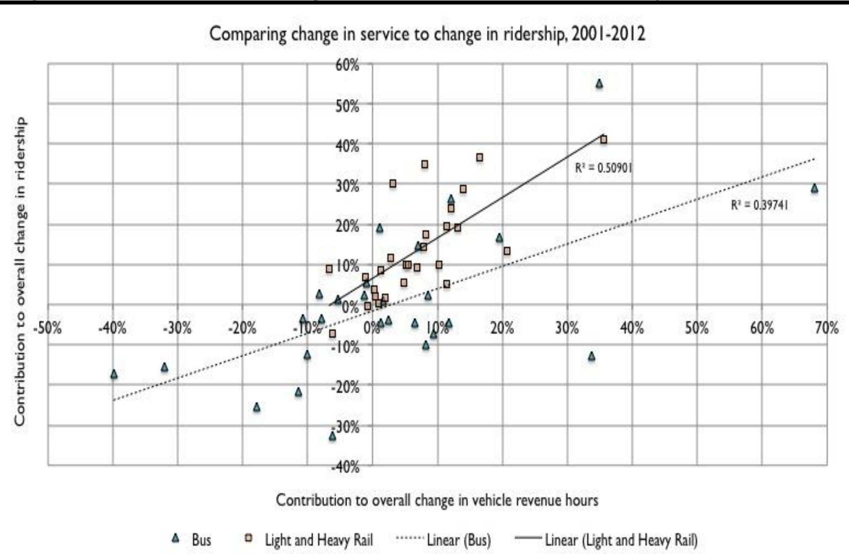
Figure 5 **Change in Bus Ridership Versus Bus Service Hours** (Walker 2015)



Increasing bus service hours tends to increase transit ridership.

Figures 5 and 6 illustrate the positive relationships between transit hours of service and ridership in various U.S. cities: where service increases so does ridership.

Figure 6 **Ridership Versus Service Hours** (Freemark 2014)



Increasing transit service hours tends to increase transit ridership and reduce automobile travel.

Schumann (2005) found that after Sacramento, California built a rail system, transit ridership increased, operating costs grew less, and voters approved more transit funding than in Columbus, Ohio, which only offers bus transit. Freemark (2014a) found that between 2001 and 2012, rail transit ridership increased more than bus ridership, and transit mode shares declined far less in cities that established rail transit systems during the 1980s than otherwise similar metro areas that did not.

There is uncertainty concerning future transit demands. Consumer surveys indicate growing demand for high quality transit and TOD, particularly among younger people (Circella, et al. 2017; NAR 2015). Critics argue that emerging technologies, such as ride hailing services and autonomous vehicles, will reduce transit demand (Cox and Kotkin 2017), but their actual impacts are likely to be mixed, reducing transit demand in some ways and increasing it in others. New mobile navigation and payment systems can make transit more convenient (Bouton, et al. 2015). Ride hailing and self-driving taxies can improve transit station access, and reduce private vehicle ownership. Since ride hailing and self-driving vehicles require as much road space as private cars, they may increase congestion unless roads are efficiently priced, which will increase demand for high quality transit in urban areas (Schmitt 2016; TRB 2017). These trends can increase demand for high quality transit and TOD.

Critics cite Pickrell (1992) and Flyvbjerg (2002), who used older data (mostly before 1980) to argue that rail projects fail to achieve ridership targets, but modeling has improved (CTOD 2009a; FTA 2007) so most recent projects meet or exceed projections (Henry and Dobbs 2013).

The National Association of City Transportation Officials (NACTO) recommends using specific performance indicators to measure and report how public transit service improvements affect transit ridership (NACTO 2018).

Autonomous Taxis will Soon Eliminate Transit Demand

Transit critics claim that private autonomous vehicles will soon eliminate the need for public transit (O'Toole 2017), based on optimistic predictions of their benefits by industry advocates (Kok, et al. 2017). More objective analyses suggests that autonomous vehicles will take many years to develop, cost more, and provide smaller net benefits than optimists assume (Grush 2016; Simonite 2016). For example, the University of Michigan's Mobility Transformation Center director Huei Peng, said that, "it may be decades before a vehicle can drive itself safely at any speed on any road in any weather" (Truett 2016). Similarly, the Toyota Research Institute (TRI) CEO Gill Pratt, stated that autonomous driving, "is a wonderful goal but none of us in the automobile or IT industries are close to achieving true Level 5 autonomy." (Ackerman 2017).

Although current technology allows Level Four automation (vehicles can drive themselves under many conditions, but require a qualified driver able to take control when necessary), significant progress is needed for reliable Level Five automation (vehicles can drive themselves under all normal conditions), and several years will be needed for regulatory testing and approve before they are widely used. Even if self-driving vehicles become commercially available early in the 2020s, they will initially be expensive and limited in performance, since no current technologies allow reliable operation in heavy rain or snow, or on unpaved roads.

Optimists argue that, because human error contributes to 90% of crashes, autonomous vehicles will reduce crash and insurance costs by 80-90%. This ignores additional risks these technologies introduce including hardware and software failures, hacking, offsetting behaviour (additional risks travellers take when they feel safer), and platooning (vehicles driving close together on a dedicated highway lane) dangers. These risks may offset much of the expected safety gains, reducing savings and the justification for public policies to favor self-driving vehicles.

Optimists predict that electric autonomous vehicles will costs 10¢ to 35¢ per vehicle-mile, and less if shared (Kok, et al. 2017), but such predictions ignore the additional equipment and mapping costs, plus taxis service costs such as cleaning, empty miles to pick up and drop off passengers, and business profits. Shared mobility services are only convenient and inexpensive in dense urban areas where taxis can respond quickly are require minimal extra travel (RPA 2017). As a result, autonomous taxis are likely to encourage more compact and multimodal urban development, and increase travel demands on major urban corridors.

Autonomous vehicles do not reduce traffic congestion except when operating on dedicated highway lanes where they can platoon (several coordinated vehicles driving close together). Small vehicles, including shared autonomous taxis, cannot carry the travel volumes required on major urban corridors, and by increasing total vehicle travel, autonomous vehicles can increase total traffic problems including congestion, accidents and pollution emissions, unless public policies favor public transportation (Shared Mobility Principles 2017).

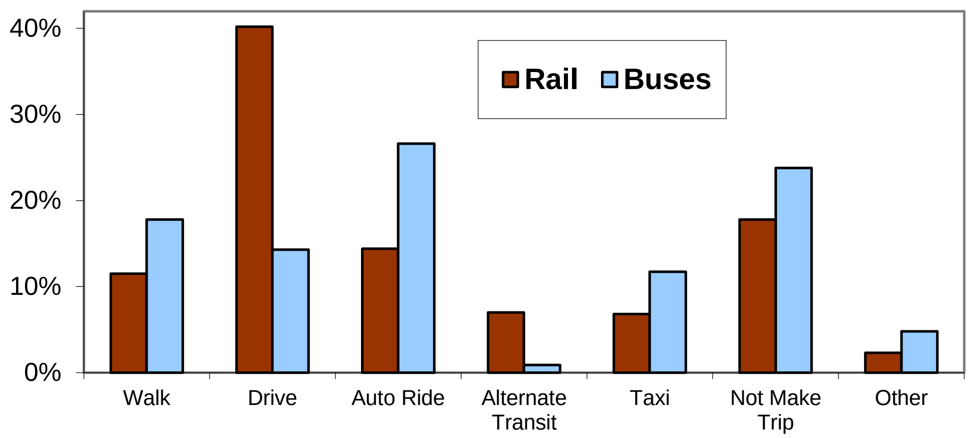
Autonomous technologies, such as self-driving buses and transit station shuttle services, can make public transit more convenient and cost effective. In these ways, autonomous driving technologies can increase the future importance of high volume public transportation. Although autonomous technologies may change public transit, they do not eliminate public transit demands and the benefits of serving those demands (RPA 2017).

Transit Improvements Do Little to Reduce Automobile Travel

Critics claim that transit does little to reduce automobile travel and traffic problems, but their evidence is incomplete and biased. Critics argue that transit service improvements, such as new rail lines, cause little reductions in regional automobile mode shares, but this confuses local and regional impacts, and mode share and total vehicle travel. High quality transit usually does significantly increase transit ridership and reduce automobile travel on affected corridors, but in most North American cities too few corridors have such service (particularly grade-separated rail or bus) for their local impacts to be perceived in regional travel data.

High quality transit tends to reduce driving more than basic transit services: often more than half of urban rail passengers would otherwise drive (Arrington, et al. 2008; Boarnet and Houston 2013; CTS 2013; Lane 2008; Xie 2012), as indicated in Figure 7.

Figure 7 **Alternative Travel Option** (APTA 2007, Table 20)



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

In addition to trips that shift from auto to transit, high quality transit and Transit Oriented Development have *leverage effects*, so small increases in transit ridership are associated with proportionately larger reductions in automobile travel. This occurs because they create compact, multimodal neighborhoods where residents own fewer vehicles, drive less and rely more on non-auto modes (Bento, et al. 2003; CTS 2013; ICF 2010). For example, Arrington, et al. (2008), found that TOD residents own about half as many vehicles and generate about half as many vehicle trips as in conventional, automobile-oriented development, and Gard (2007) found that they generate 8-32% fewer automobile trips than residents of conventional developments.

To account for these factors, accurate analysis measures travel impacts based on reductions in per capita vehicle-miles travelled (VMT) by affected travellers or residents. When measured this way, high quality transit and TOD often have large impacts and benefits.

Harms Disadvantaged People

Critics argue that investments in high quality transit and Transit Oriented Development harm physically and economically disadvantaged people who prefer basic transit services and cheaper housing. They point to fare increases and bus service reductions that occurred during periods of urban rail development, and housing price increases near rail transit stations. Although there are sometimes trade-offs between higher-quality and basic transit services, it is wrong to assume that it always occurs, or to ignore the benefits that high quality transit and TOD can provide to disadvantaged travellers.

Analysis of transit ridership trends in various cities found that (Lewyn 2015):

- Of nine regions that experienced bus ridership losses exceeding 20% (Baltimore, Atlanta, Dallas, Cincinnati, Houston, Cleveland, Detroit, Milwaukee, San Jose) four (Baltimore, Dallas, Houston, San Jose) had built significant new rail in the past couple of decades, but five other cities that experienced major bus ridership declines either lack significant rail service or (in the case of Cleveland) or have older rail systems. By contrast, of 30 other regions that experienced ridership gains or small ridership losses, 13 added new rail service. In other words, about one-fourth of new rail cities (4 of 17) and about one-fourth of other cities (5 of 22) suffered major ridership losses. Thus, associations between rail and reduced ridership are small or nonexistent.

- The association between new rail and bus service cuts is even weaker. Since 2000, six urbanized areas (Cleveland, Milwaukee, Pittsburgh, Detroit, San Jose, Houston) reduced bus route-miles by over 20%, but only two of these regions (San Jose and Houston) have significant new light rail systems. (Two more, Cleveland and Pittsburgh, are "legacy rail" cities with older rail systems).

- Of 17 cities that added significant rail service since 2000, 10 reduced bus route-miles to some extent and 7 added route-miles. By contrast, 5 of the 12 cities with little or no rail service reduced bus service, as did 7 of the 10 "legacy rail" cities. Thus, new rail cities are more likely reduce service than "no rail" cities, but less likely than "legacy rail" cities indicating that the correlation between light rail and reduced bus service is pretty weak or nonexistent.

- Moreover, some cities with new light rail have significantly increased both bus service and bus ridership. Charlotte is no. 1 in both; since 2000, ridership increased by 80% and bus service by 65%. Phoenix, another new rail city, is no. 3 in ridership increases and no. 2 in service increases; both have increased by 57% since 2000. So even if new rail cities are more likely than other cities to reduce bus service, it does not appear that new rail cities consistently do so.

In sum, it appears that at least some cities that built more rail have also added bus service and cities that have done so have usually experienced higher bus ridership.

Urban rail funding often consists of money shifted from highways, or new revenues justified by the political popularity of rail. Because high quality transit tends to increase total transit demand, cities with urban rail tend to have more bus service than in automobile-dependent cities. This indicates that high quality transit and TODs can benefit disadvantaged people, provided it includes affordable housing (CTOD 2009b; Pollack, Bluestone and Billingham 2010).

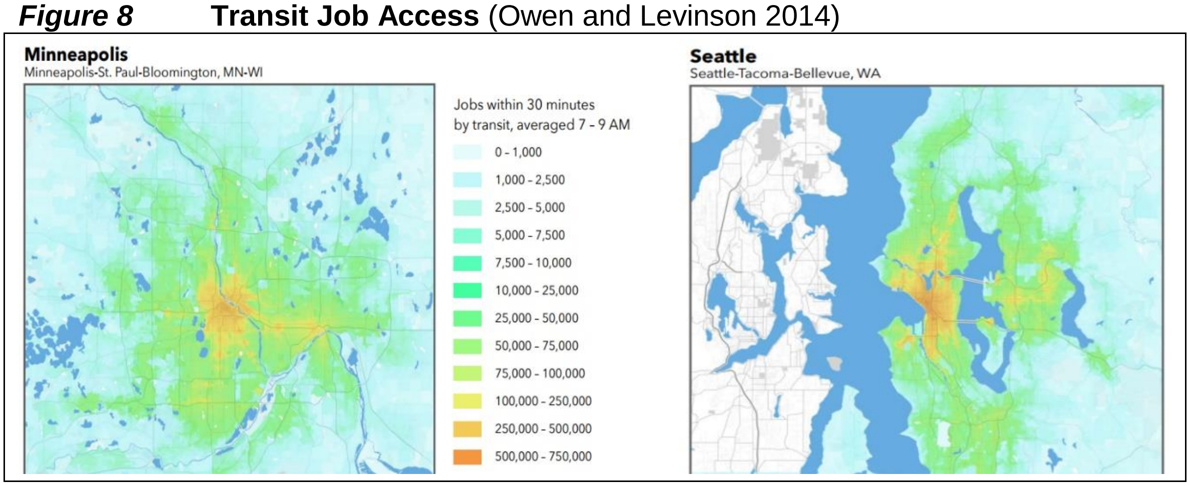
Critics argue that economically disadvantaged people benefit from automobile transportation and therefore from automobile-oriented transport planning. This ignores the diversity of disadvantaged people’s travel demands and the full costs of automobile use. Many disadvantaged people cannot or should not drive, and automobile ownership imposes significant direct and indirect costs, including vehicle ownership and operating expenses, financial and legal risks caused by vehicle failures, crashes and traffic citations, traffic crash risks, and health problems associated with sedentary living. As a result, although automobile travel can benefit some disadvantaged people, this does not reduce the significant benefits they can gain from transit improvements and TOD, benefits that tend to be particularly large when all impacts are considered.

Critics cite studies such as Sullivan (2003) which found that low-education workers who owned cars averaged $1,100 higher monthly incomes than those who did not, but the results do not account for confounding factors: workers who earn more are more able to afford cars, and some workers cannot drive. A more recent and sophisticated study by Smart and Klein (2015) found that after shifting from being carless to owning one car, a typical low-income family earned approximately $2,300 more but spent more than $4,100 annually to own and maintain that vehicle, so the incremental income was insufficient to pay the additional costs.

Living in a TOD significantly reduces household transportation costs, and so can increase affordability overall, provided that TODs include lower-priced as well as higher-priced housing. Disadvantaged people often choose rail and TOD due to the improved convenience, comfort and accessibility they provide (CNT 2010; CTS 2013). Research described later in this report indicates that high quality transit provides substantial savings, particularly for lower-income households.

The study, *Access Across America: Transit 2014* (Owen and Levinson 2014) compared 46 major U.S. cities based on transit job accessibility. All of the highest ranking cities (New York, San Francisco, Los Angeles, Washington D.C., Chicago, Boston, Philadelphia, Seattle, Denver, San Jose and Portland) have urban rail systems. The maps below show the relatively high levels of transit job access along major transit lines. People who cannot drive or afford a car benefit significantly by living in such areas.

Figure 8 **Transit Job Access** (Owen and Levinson 2014)

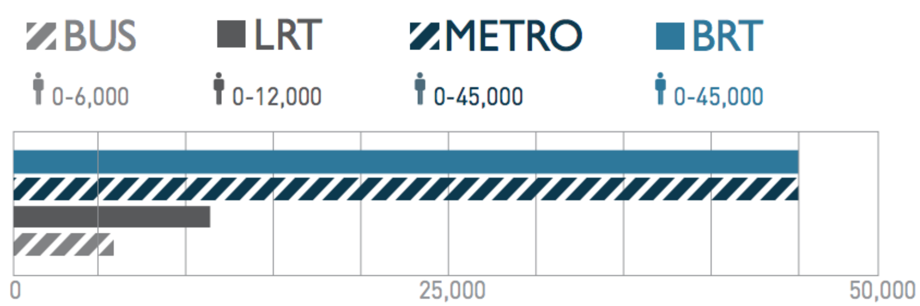


These maps from "Access Across America: Transit 2014" show the greater job access in central areas with higher quality transit. Lower-income workers can benefit significantly by living in TODs.

Basic Bus Transit Is More Cost Effective than Rail or BRT

High quality transit is costly to build and so is not justified everywhere, but on major travel corridors with significant demand (exceeding about 6,000 peak-hour passengers), grade-separated transit is often cheaper per passenger-trip than basic bus services because its higher capital costs are repaid over the long run with lower operating costs and increased ridership.

Figure 8 **Transit Capacity** (ITDP)



High quality transit (urban rail and BRT) is justified on corridors with more than about 6,000 potential passengers per peak-hour.

Rail tends to perform better economically. On average, rail has approximately twice the operating speed, half the cost per passenger-mile, and twice the cost recovery of bus transit, as illustrated in Table 3. This is not to criticize buses, they generally operate with in mixed traffic in conditions with lower demand, and therefore low load factors, but this does indicate that rail transit or BRT can provide superior performance with implemented with supportive development policies.

Table 3 **Rail Versus Bus Performance** (APTA 2017, Tables 2 & 29)

	Rail	Transit Bus
Average operating speed	21.7	12.2 mph
Operating costs (millions)	$16,565	$20,164
Fare revenue (millions)	8,637	5,166
Passenger Miles (millions)	32,789	19,380
Cost Per Passenger-mile	*$0.51*	*$1.04*
Cost Recovery	*52%*	*26%*

Rail transit tends to provide better performance (higher speed, more cost efficiency and greater cost recovery) than bus transit. Critics are wrong to argue that bus transit is more efficient and cost effective than rail.

Transit is Subsidized, Automobile Travel is Not

Critics claim that public transit is subsidized, and so fails to reflect consumer willingness-to-pay, while automobile transport is funded by users and so is economically efficient (the prices that users pay reflects marginal production costs). This is incomplete analysis.

It is true that most public transit services depend on direct subsidies, which cover about 70% of total rail costs and 80% of total bus costs (APTA 2016, p. 9), but automobile travel also requires substantial subsidies; although road user fees (special fuel taxes, vehicle registration fees and road tolls) finance most highway costs, local roads are primarily funded by local taxes which residents pay regardless of how they travel. Overall about half of total roadway costs are subsidized by general taxes, and automobiles require parking at each destination, most of which is subsidized directly by governments or indirectly through government-mandates. In typical urban areas there are 2-5 non-residential off-street parking spaces per vehicle, with annualized costs of $500-2,000 each, and automobile travel imposes other external costs including traffic congestion, barrier effect, accident risk and pollution emissions, tend to be particularly large under urban-peak travel conditions (Davis, et al. 2010; Litman 2009). Comparing the costs of different modes is challenging since the results depend on which costs and subsidies are considered, how they are calculated, and which travel conditions are considered (ATAP 2017; Litman 2017), but under typical urban conditions, accommodating additional transit trips has lower costs and subsidies than accommodating more automobile trips on the same route. Described differently, when motorists are required to pay efficient road and parking fees that internalize costs, urban-peak automobile travel tends to decline significantly, indicating that a significant portion of automobile travel is economically inefficient.

Transit Investments are Unfair to Motorists

Critics argue that investments in public transit are unfair to motorists by diverting resources, particularly road user fees such as special fuel taxes and tolls, from highway improvements. Their arguments overlook important factors.

Horizontal equity (fairness) requires that consumers “get what they pay for and pay for what the get” unless a subsidy is specifically justified. Although motorists pay fuel taxes and tolls that finance most highway expenses, local road are financed primarily by general taxes that people pay regardless of how they travel. As a result, people who drive less than average tend to subsidize the roadway costs of those who drive more than average. If fairness requires that all road user fees be dedicated to roads, it also requires that user fees should cover all roadway costs, so non-drivers are not forced to subsidize roadway costs required by motorists. Using a portion of road user fees to finance transit simply offsets some of the subsidy motorists currently receive from non-drivers.

Funding public transit can also be considered a way for motorists to help mitigate the external costs they impose on society, including congestion delay, accident risk and pollution emissions that automobile travel imposes on non-drivers. The effectiveness of traffic safety strategies that reduce higher-risk driving, such as graduated licenses, special restrictions on older drivers, and anti-impaired driving campaigns, depends on those travellers having suitable travel options, for example, that younger people can get to school and work, and drinkers can get home from bars and restaurants, without driving. High quality public transit and transit-oriented development help do that, increasing safety for all road users. Dedicated lanes for high occupant vehicles are justified on efficiency and fairness grounds, so people using space-efficient modes – buses and vanpools – are not delayed by the congestion caused by more space-intensive motorists.

In addition, motorists benefit from public transit, particularly high quality services on major urban corridors that reduce their traffic and parking congestion, accident risk, and chauffeuring burdens. Just as ship passengers value having lifeboats available for possible emergency use, many motorists recognize the value of having transport options that they do not currently use, but may need in the future.

Figure 10 **A Fair Share of Transportation Investments**

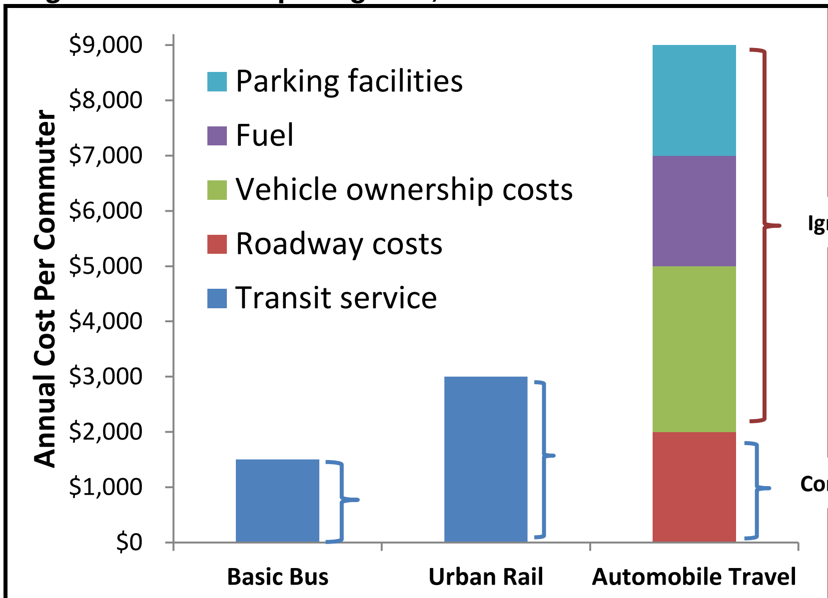
In any city, a portion of travellers cannot, should not or prefer not to drive and therefore demand non-automobile travel options. An efficient and equitable transportation system responds to those demands, and recognizes that motorists can benefit from public transit improvements that reduce their traffic and parking congestion, accident risk and chauffeuring burdens. Critics ignore these issues.

Not Cost Effective

Critics argue that transit improvements are expensive and not cost effective (costs exceed benefits), or less cost effective than automobile improvements (O'Toole 2006; Cox 2010; Castelazo and Garrett 2004; Winston and Maheshri 2006), but their analysis often overlooks or undervalues major transit benefits and urban highway expansion costs.

Critics often compare transit system costs, which include rail or busway facilities, stations, vehicles and operating expenses, with just highway costs, which ignores other costs required for automobile travel including vehicles, fuel and parking facilities, and they sometimes compare the costs of high quality transit on major urban corridors with *average* highway expansion costs, ignoring the very high costs of expanding highways and parking facilities in central city areas. Expanding urban highways often costs more than $1.00 per additional peak-period vehicle-mile (Decorla-Souza and Jensen-Fisher 1997; Litman 2009, "Roadway Costs").

Figure 11 **Comparing Bus, Rail and Automobile Commute Costs** (Litman 2009)



Conventional analysis often compares transit service costs, including rails or busways, stations, vehicles and sometimes operating expenses, with just roadway costs, ignoring other automobile travel costs including parking facilities, vehicles and fuel. For a typical urban commute, transit is often cheaper overall than the full costs of accommodating more automobile trips on the same corridor.

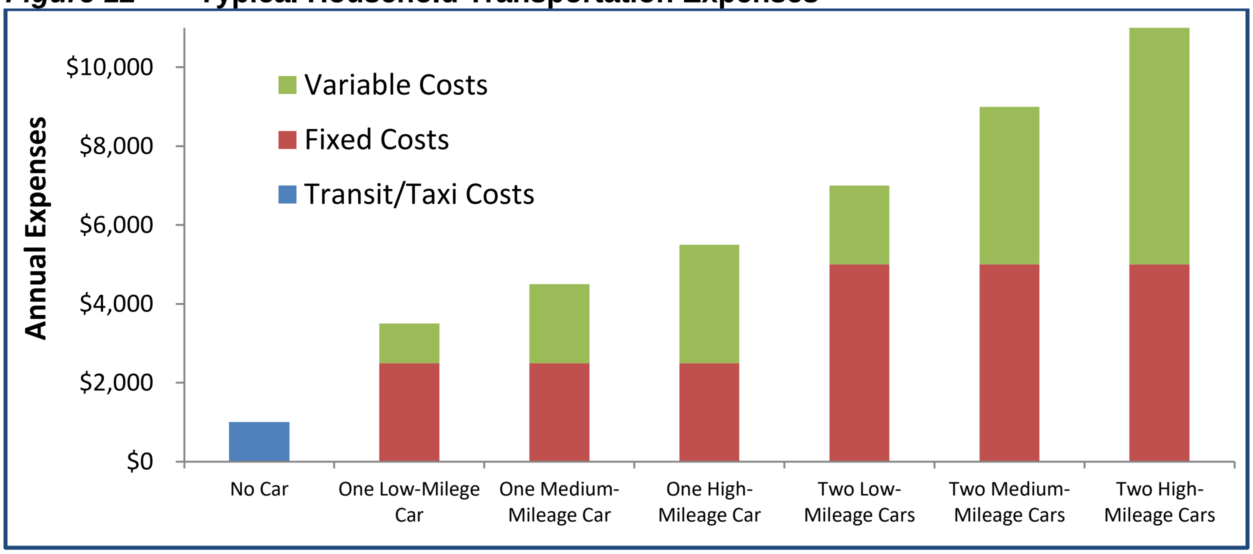
Critics sometimes argue that it would be cheaper to give travellers new cars than to build urban rail systems but this ignores other costs: each vehicle also require additional road capacity, parking spaces, fuel and other operating expenses, and for many transit users, a driver. Ride hailing and autonomous taxi services also need additional road capacity, and so are generally more costly than high quality public transit for travel on major urban corridors.

Critics often use selective data to exaggerate the portion of transportation funds devoted to public transit. During periods of major expansion, such as when a new rail line is under construction, such projects may represent a major portion of regional transportation capital spending, but this generally represents a minority of total transport spending by all levels of government. For example, in 2014, U.S. rail transit capital spending totaled $13 billion, less than 10% of the $135 billion roadway capital spending (including interest and bond payments), and a tiny portion of total spending on roads and parking facilities.

Critics only consider a few transit benefits, such as reduced traffic congestion and per-mile pollution emission rates, but ignore other important impacts including parking cost savings, consumer savings and affordability, improved mobility for non-drivers, public fitness and health, and strategic development. Critics often underestimate the full costs of accommodating additional automobile travel on major urban corridors, including the high costs of expanding roadways and increasing parking supply. They generally ignore generated traffic impacts (additional vehicle traffic induced by roadway expansions), which exaggerates congestion reduction benefits and underestimates the incremental external costs such as additional downstream congestion, accidents and pollution caused by highway expansions.

Critics generally ignore consumer savings and affordability (savings to low-income households). Of course, transit is not always cheaper than driving since fares are often comparable to automobile operating costs, but high quality transit and TOD can provide large savings, totaling thousands of dollars annually, if they allow households to reduce vehicle ownership. Figure 12 illustrates typical expenses for various levels of vehicle ownership and use, assuming a basic car has $2,500 in fixed expenses (financing, time-based maintenance and depreciation, insurance and registration fees, and residential parking), and 20¢ per mile in operating expenses (fuel, tire wear, distance-based depreciation, parking fees, tolls and traffic citations).

Figure 12 **Typical Household Transportation Expenses**



A basic car typically costs about $2,500 in fixed expenses and 20¢ per mile in operating expenses. By reducing vehicle ownership and use, high quality transit and TOD can provide large savings.

Not all transit users take full advantage of these potential savings. Many households spend more on vehicles than functionally required, for convenience or status sake, but the potential to reduce vehicle costs is particularly important for lower-income households, and so increases affordability and economic resilience. Various studies find that residents of more compact and multimodal communities spend a smaller portion of their budgets on transportation than comparable residents in more sprawled, automobile dependent areas (CTOD and CNT 2006). For example, Bailey (2007) found that, other factors held constant, households located within 0.75 miles of high quality public transit saved approximately $1,400 in fuel costs and $5,586 in total transport costs (vehicle ownership and operating savings minus additional transit fares).

For example, after Seattle's 14-mile Link rail service began operation in 2009, transit mode share increased from 10% to 12% countywide, and from 42% to 45% downtown, resulting in about 32,000 additional daily downtown transit trips (https://commuteseattle.com). Table 4 estimates resulting road and parking cost savings, assuming that 66% of the new transit commuters would otherwise drive, that major urban highway expansion projects cost $30-100 million per lane-mile, and downtown parking costs $30,000-60,000 per space (WSDOT 2004; Litman 2009). These are lower-bound values since they ignore incremental road and parking operating costs.

Table 4 **Estimated Savings from 32,000 Downtown Transit Commutes**

	Low Estimates		High Estimates	
	Unit Costs	Total Savings	Unit Costs	Total Savings
Urban roadways	$30 million/lane-mile	$1.6 billion	$100 million/lane-mile	$5.3 billion
Downtown parking	$30,000/space	$0.66 billion	$60,000/space	$1.3 billion
Totals		*$2.2 billion*		*$6.6 billion*

This analysis estimates that 32,000 additional transit commuters reduce between $2.2 and $6.6 in road and parking costs. (Assumes that 66% of city center downtown transit commuters would otherwise drive, 4,000 average peak-period vehicles per traffic lane, and 10-mile average commutes.)

These infrastructure savings compare favorably with Link's $2.6 billion capital costs. Not all of the additional downtown transit trips use Link, local and regional bus services were also improved during that period, but on the other hand, transit ridership is also growing to other Puget Sound area destinations, providing additional road and parking infrastructure savings.

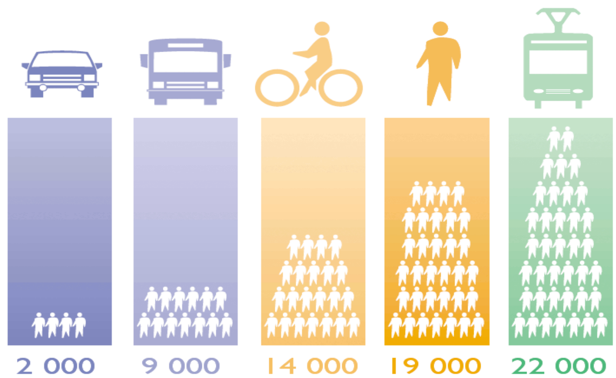
Several studies indicate that rail transit services provide net benefits to society even though most of these consider only a few categories of benefits. For example, Parry and Small (2007) conclude that fare subsidies of 50% are welfare improving (provide net benefits to society), considering congestion,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

Transit Does Not Reduce Traffic Congestion

Critics use inaccurate analysis to argue that public transit cannot reduce traffic congestion (Cox and O'Toole 2004; Rubin and Mansour 2013).

Public transit is space-efficient, as illustrated in Figure 13. Shifts from automobile to transit can reduce traffic and parking congestion. Of course, not every transit system operates with maximum capacity, and not all transit passengers would otherwise drive, but high quality transit tends to attract discretionary travellers, which reduces congestion.

Figure 13 **Urban Travel Mode Space Efficiency** (UITP 2013)



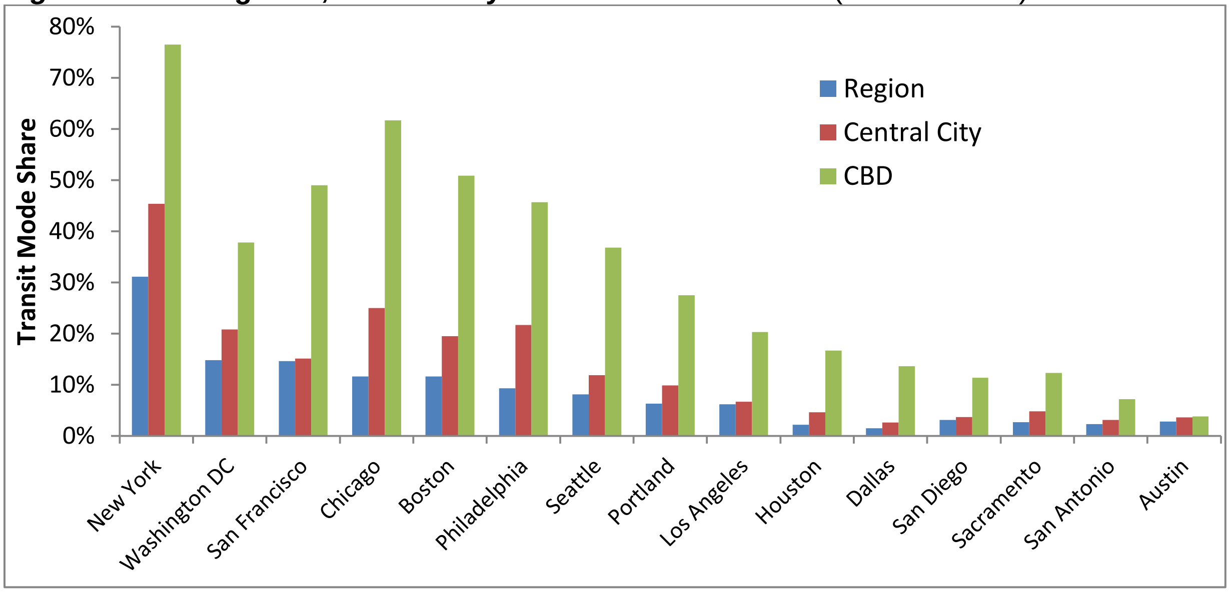
Number of people crossing a 3.5-meter-wide space in an urban environment during a one-hour period.

With a given amount of space, buses can carry about five times, and trains up to ten times, as many passengers as single-occupant automobiles. They also reduce vehicle parking needs. By attracting discretionary travellers, high quality public transit reduces traffic and parking congestion.

Traffic congestion tends to maintain equilibrium: traffic volumes increase to the point that congestion discourages further peak-period vehicle trips. The point of equilibrium is affected by the quality of travel options: if alternatives to driving are inconvenient or uncomfortable, congestion may become severe before travellers shift mode, but if they are attractive, less incentive is needed to reduce vehicle traffic. Improving alternative modes, such as grade-separated transit, tends to reduce the point of congestion equilibrium; congestion does not disappear but is less severe than would otherwise occur. When transit is faster than driving, a portion of travelers shift until the highway reaches a new equilibrium, that is, until congestion declines to the point that transit is no longer faster. As a result, the faster the transit service, the faster the peak-period traffic speeds on parallel highways. The actual number of motorists who shift to transit may be relatively small, but is enough to reduce delays. Congestion does not disappear, but it never gets as bad as would otherwise occur. These shifts from automobile to transit also reduce "downstream" congestion, for example, if a highway bus lane reduces traffic volumes being discharged onto surface streets.

Critics use regional travel data to argue that public transit carries too few trips to reduce congestion. In most urban regions transit serves a small portion of total trips but much larger portions of peak-period trips on major travel corridors, as illustrated in Figure 14. Even in cities with relatively modest transit networks, where transit serves just a few percent of total regional trips, it often represents 5-15% of central city commutes and 10-50% of peak-period trips to major activity centers such as central business districts (CBDs) and campuses. Since these corridors tend to have the most severe congestion, the potential benefits of automobile-to-transit mode shifts tend to be much larger than indicated by regional data.

Figure 14 **Regional, Central City and CBD Mode Shares** (Pisarski 2006)



Although transit is typically just 1-3% of total regional mode share, it represents a larger portion of urban commuting (typically 5-10%) and an even greater share of peak-period travel to major activity centers such as central business districts (CBDs) and campuses (typically 10-50%). As a result, public transit service quality can significantly affect traffic congestion.

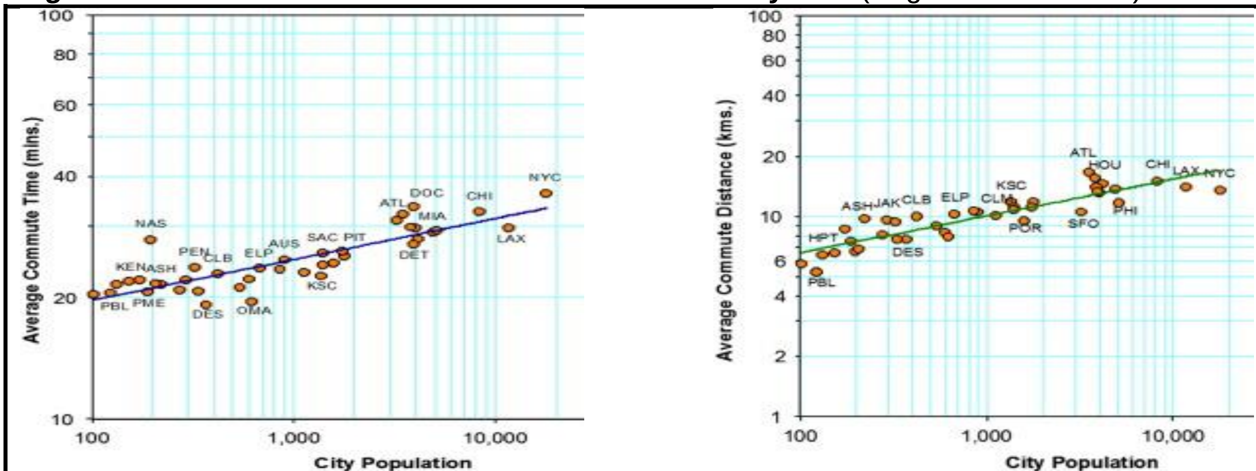
Numerous studies indicate that high quality transit reduces traffic congestion (Aftabuzzaman, Currie and Sarvi 2010). These benefits can be large since high quality transit services tend to operate on urban corridors where congestion is most severe, so small shifts in regional mode share can provide large congestion reductions.

For example, although only 11% of Los Angeles commutes use transit, when a strike halted transit service for five weeks, average highway congestion delay increased 47%, and regional congestion costs increased 11% to 38% (Anderson 2013), with particularly large speed reductions on rail transit corridors (Lo and Hall 2006). Ewing, Tian and Spain (2014) found that the Salt Lake City's University TRAX light-rail system reduced daily vehicle traffic on the study corridor about 50%, from 44,000 (if the line did not exist) to 22,300 (what currently actually occurs). Winston and Langer (2004) found that U.S. cities' congestion costs decline as rail transit mileage expands, but increase as bus mileage expands, apparently because buses have lower automobile substitution rates, contribute to congestion, and do little to increase land use accessibility. Baum-Snow and Kahn (2005) found significantly lower average commute travel times in areas near rail transit stations than in otherwise comparable locations without rail. Traffic volumes decreased 6.4% on a parallel highway after the Hiawatha rail line was completed, although regional traffic grew during that period (Kim, Park and Sang 2008).

High quality transit also complements congestion pricing: it reduces the toll required to achieve a given reduction in traffic volumes and congestion delays (Parsons Brinckerhoff 2013; PSRC 2008) and can help build public support for other congestion reduction strategies such as efficient road and parking pricing, and commute trip reduction programs.

Critics argue that transit commutes are slower on average than automobile commutes (Cox and Kotkin 2017). This reflects the additional time often required to access transit, the tendency of commute duration and transit mode share to increase with city size, and the very long duration commutes borne by non-drivers in sprawled, automobile-dependent areas (Figure 15).

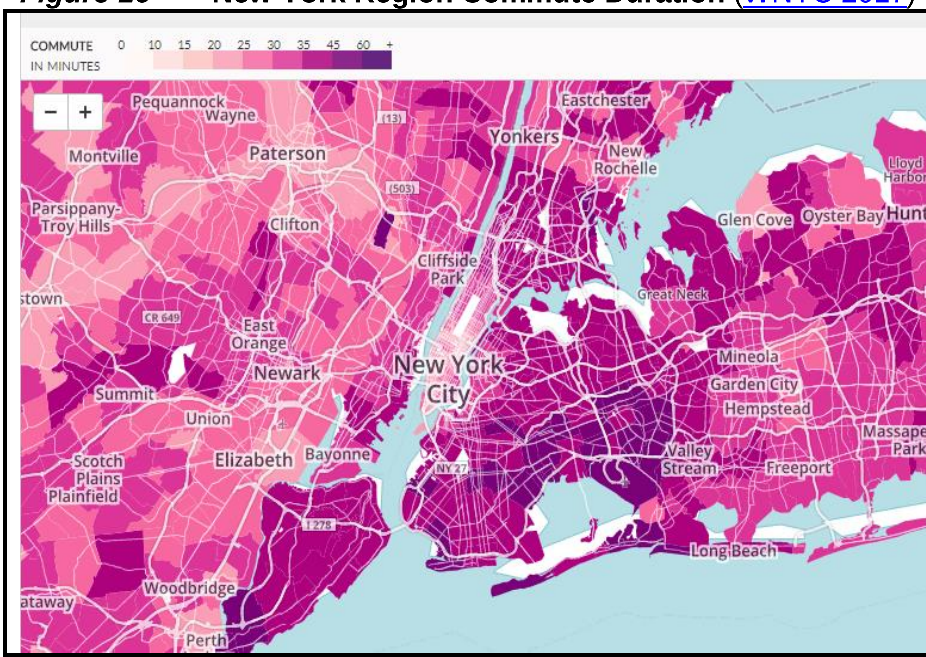
Figure 15 **Commute Distance and Time Versus City Size** (Angel and Blei 2016)



Commute distance and time, and transit mode share, all tend to increase with city size. This helps explain why commute duration tends to increase with transit mode share. Transit commuting also requires extra access time, walking and cycling to stops and stations, plus waiting times, and some transit users have very long duration commutes. However, high quality, grade-separated transit is often competitive with driving.

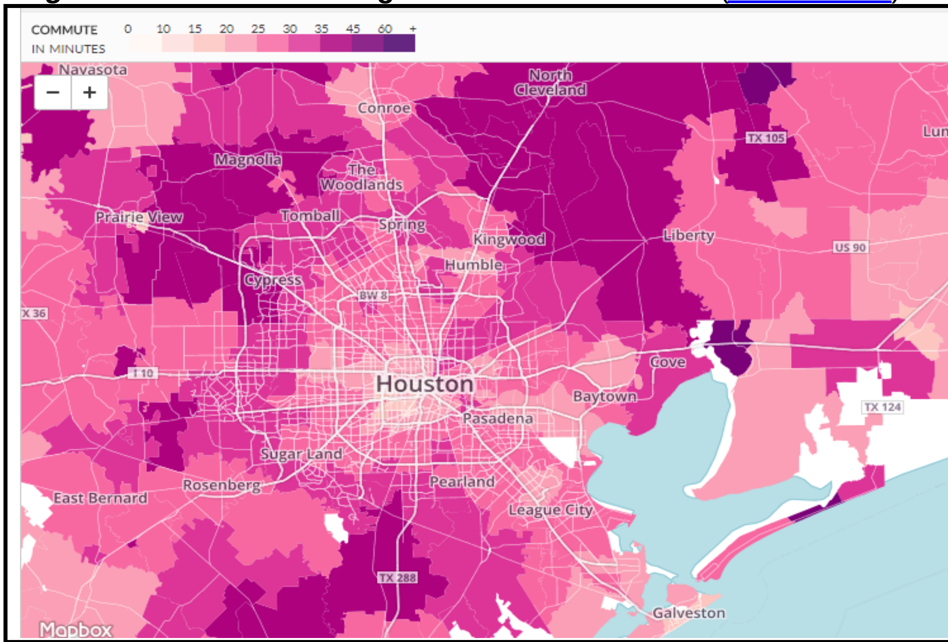
However, within urban regions, commute duration tends to increase with distance from city centers and is often shortest in transit oriented areas, as illustrated in figures 16 and 17.

Figure 16 **New York Region Commute Duration** (WNYC 2017)



Within the New York region, residents of more central and transit-oriented neighborhoods, such as lower Manhattan, have shorter commute durations than those in more distant and automobile-oriented areas such as East Brooklyn, and Summit and Eastchester.

Figure 17 **Houston Region Commute Duration** (WNYC 2017)



Residents of more central Houston neighborhoods have shorter commute durations than those in more distant and automobile-oriented areas such as Magnolia, Arcola and Roman Forest.

There are additional factors to consider when comparing transit and automobile travel time:

- Because transit often has lower user costs than driving, particularly for urban commutes, public transit often has lower *effective speed* (travel time plus time spent earning money to pay vehicle expenses or fares) than automobile travel. Most moderate-wage workers (those earning less than $25 per hour) are economically better off spending an extra hour commuting by transit than paying $5,000 annually to own a car for commuting, and even more if automobile commuters must pay tolls or parking fees.

- Much of the additional time required for transit commuting consists of walking or biking to transit stops, which many people consider desirable for health and enjoyment sake, and if transit services are convenient and comfortable, many people prefer transit over automobile commuting because they can relax or work while travelling. As a result, many commuters prefer a longer duration transit trip over a somewhat faster but more stressful automobile trip.

- Because transit-oriented neighborhoods are compact and multimodal, residents tend to spend less time driving for local errands and chauffeuring, and so spend less total time travelling than in automobile-oriented areas.

- Transit service improvements and Transit Oriented Development can reduce travel time costs by improving transit speeds, reducing trip distances, improving transit travel comfort, and by reducing congestion delays to motorists on parallel roads. As a result, the longer average durations of transit commutes is a justification for more rather than less investment in high quality transit and TOD.

Of course, commute needs and preferences vary: travellers prefer using transit for some trips and driving for others. Providing high quality transit allows travellers to choose the best option for each trip, including public transit commuting when it is the most efficient overall, considering all costs.

Transit Benefits Often Ignored By Critics

Critics often overlook the following public transit improvement benefits.

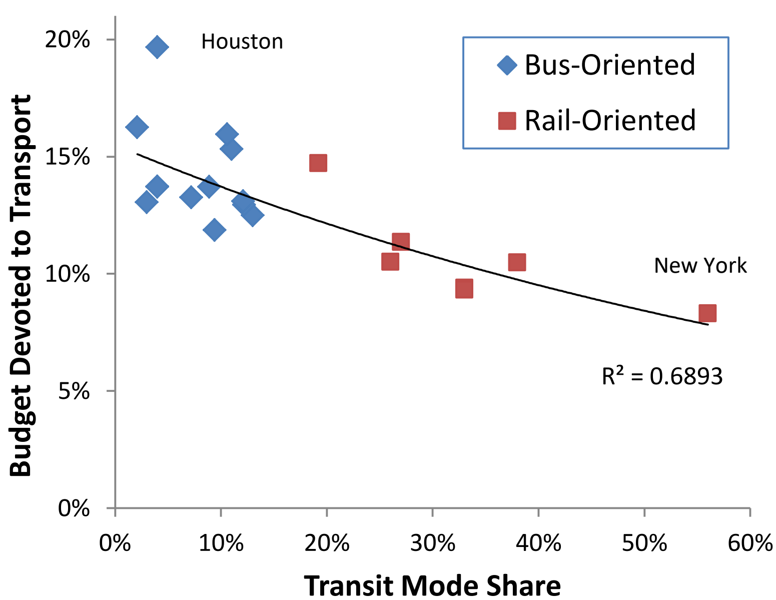
Increased User Convenience and Comfort

Conventional transportation planning evaluates transport system performance based primarily on travel speeds and delay, with little consideration for user convenience and comfort. This may be appropriate for automobile planning, since motorists can control their own convenience and comfort by purchasing vehicles amenities such as navigation systems, air conditioning and quieter operation, but increasing transit passenger convenience and comfort requires investments in grade-separation, improved user information and payments systems, nicer vehicles and stations, and improved local pedestrian and cycling access. Surveys indicate that many travellers value such improvements (CNT 2012); ridership tends to increase in response to service improvements, indicating consumer welfare gains. Critics ignore the user benefits of higher quality transit services and Transit Oriented Development when they argue that existing transit passengers prefer basic bus services over rail, or that most household prefer suburban sprawl over more walkable urban neighborhoods.

Affordability and Economic Resilience

By creating multimodal communities with affordable transport options, high quality transit and Transit Oriented Development significantly reduces transportation costs. An average household saves thousands of dollars annually by locating in a rail-oriented region (Figure 18), and the *potential* savings are even larger than these statistics indicate because, for recreation and status sake, many households own more vehicles and spend more on transportation than is functionally necessary. More affordable transport allows households to save money when needed, for example if they lose income or incur unexpected expenses, which helps explain lower housing foreclosure rates in more multimodal communities (NRDC 2010).

Figure 18 **Transportation Spending Versus Transit Mode Share**

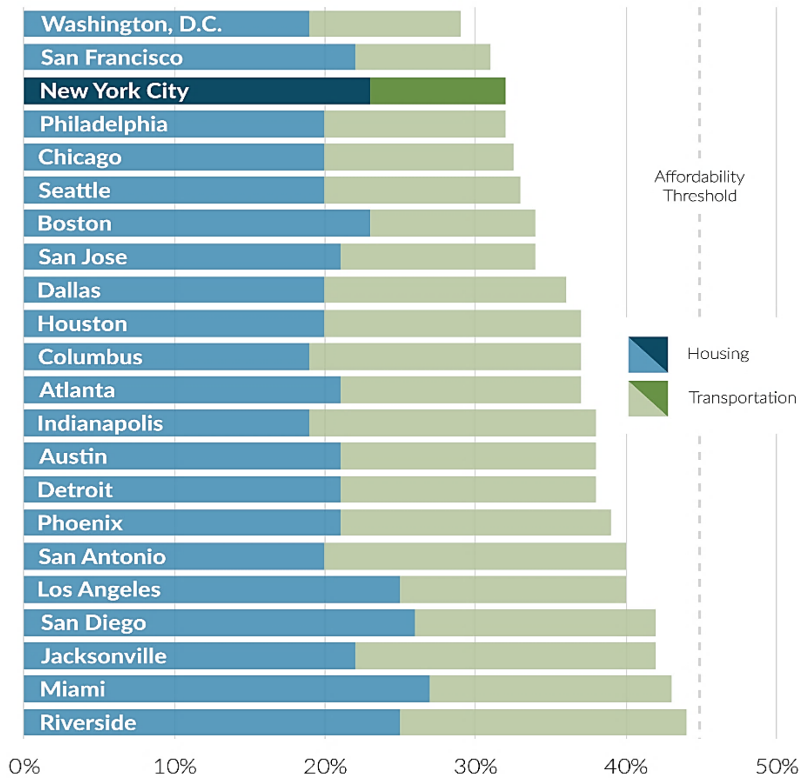


The average portion of household budgets devoted to transportation (vehicles, fuel and transit fares) declines in urban regions as transit mode share increases. Regions with urban rail systems tend to have the highest transit mode shares and the lowest household transportation spending, representing thousands of dollars in annual savings for an average household.

Based on BLS "Consumer Expenditure Survey" and the US Census "2012 American Community Survey" data.

Similarly, total housing and transportation costs tend to be lower in cities with extensive transit systems, such as Washington DC, San Francisco and New York than in automobile-oriented cities such as Jacksonville, Miami and Riverside, because their higher housing costs are more than offset by lower transportation costs, as illustrated below.

Figure 19 **Housing and Transport Costs as Portion of Income by City** (CBC 2014)

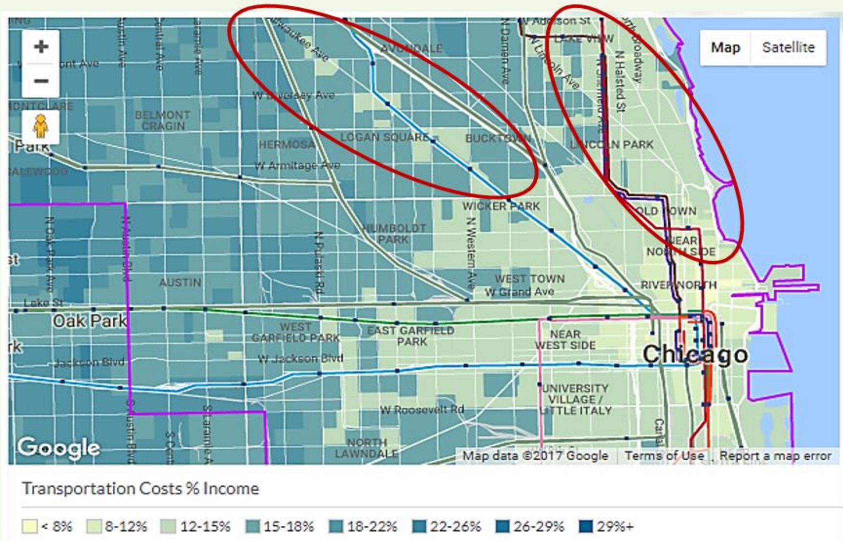


Total housing and transportation costs tend to be lower in cities with extensive transit systems, such as Washington DC, San Francisco and New York than in automobile-oriented cities such as Jacksone, Miami and Riverside, because their higher housing costs are more than offset by lower transportation costs, as illustrated below.

Source: U.S. Department of Housing and Urban Development, *Location Affordability Portal - Version 1* (accessed July 10, 2014), www.locationaffordability.info/lai.aspx.

Similar patterns occur within regions. TOD residents own about half as many motor vehicles as in auto-oriented neighborhoods and save on transport costs (Arrington et al. 2008). These savings are visible in *H+T Affordability Index* maps, such as the one below, which shows the low transportation spending in Chicago neighborhoods along rail lines (Chicago makes a good subject for rail impact research because it is flat and has a well-developed transit network).

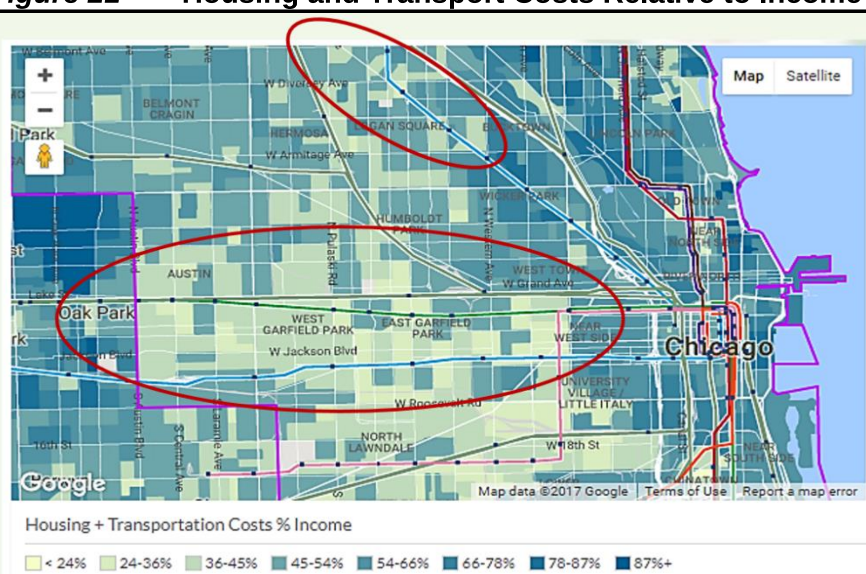
Figure 20 **Transportation Costs Relative to Income - Chicago** (CNT 2017)



Households in neighborhoods near rail lines, such as Garfield Park, Logan Square and Lakeview, spend a much smaller portion of their budgets on transport than in more automobile-orineted areas. Potential savings are particularly beneficial to lower-income households that sometimes need affordable travel options.

Critics sometimes argue that Transit Oriented Development increases housing costs, which is not necessarily true. As Figure 21 shows, combined housing and transport costs are often lower along rail lines than in more automobile-oriented areas. The most effective way to maximize overall affordability is to increase the supply of lower-priced housing in TODs.

Figure 21 **Housing and Transport Costs Relative to Income** (H+T Cost Index 2017)

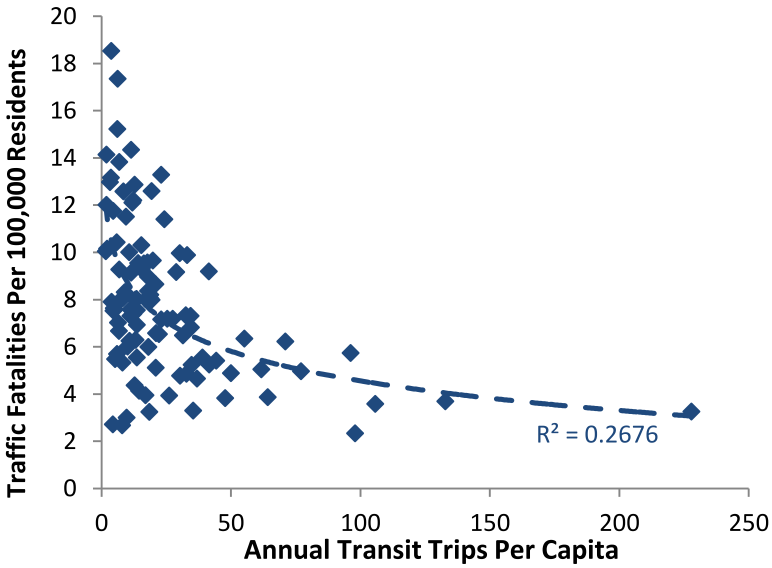


Although many factors affect housing costs, households located near rail lines often spend a smaller portion of their budgets on housing and transport combined than in more automobile-orineted areas. Increaseing affordable housing supply in TODs maximizes both housing and transportation affordability.

Traffic Safety

Per capita traffic casualty rates tend to decline as public transit ridership increases in a community (Litman 2016b; Stimpson, et al. 2014), as illustrated in Figure 22. Per capita traffic fatality rates decline significantly with increased transit ridership, and are particularly low in Transit Oriented Developments (Ewing and Hamidi 2014). Three factors can help explain these effects: First, transit travel is much safer than automobile travel per passenger-mile. Second, many community design features that increase transit use, such as compact development and walkability, tend to reduce traffic speeds and total per capita vehicle travel, which increase safety. Third, higher-risk groups, including youths, seniors and alcohol drinkers, are more likely to reduce their driving if their community has convenient transit services, increasing the effectiveness of safety strategies such as graduated licenses, senior driver testing, and anti-impaired driving campaigns. Since traffic accidents are one of the largest costs of automobile travel, these benefits are very valuable (Blincoe, et al. 2014; Litman 2009).

Figure 22 **Traffic Fatalities Versus Transit Ridership** (Litman 2016b)



This graph shows the relationship between per capita transit ridership and total pedestrian, cyclist, automobile and transit passenger) per capita traffic fatality rates for 101 U.S. cities.

As transit travel increases, traffic fatality rates tend to decline. Cities where residents average more than 50 annual transit trips have about half the average traffic fatality rate as cities where residents average fewer than 20 annual trips.

Improved Public Fitness and Health

Most transit trips include walking and cycling links, and transit-oriented communities improve walking and cycling conditions. As a result, people who use public transit and live in TODs tend to exercise more and are more likely to achieve physical fitness targets and have better health outcomes than automobile users and residents of sprawled communities (Ewing and Hamidi 2014; Frederick, Riggs and Gilderbloom 2017; Litman 2017). Lachapelle, et al. (2011) found that transit commuters average 5 to 10 more daily minutes of physical activity, and walked to local services more than people who do not use transit. As a result, the U.S. Center for Disease control advocates public transit improvements and more compact, multimodal community planning as a public health strategy (CDC 2015).

Energy Conservation and Emission Reductions
High quality public transit and Transit Oriented Development can provide significant energy conservation and emission reduction benefits (Chester and Horvath 2008; Gallivan, et al. 2015; ICF 2010; TCRP 2012). This analysis is complicated by the fact that a major portion of transit services are intended to provide basic mobility to non-drivers, such as bus services where demand is low (such as in suburban communities and during off-peak periods) are not very fuel efficient. However, high quality public transit that attracts high ridership on major travel corridors, and Transit Oriented Development which leverages reductions in residents' total vehicle travel, can provide large energy conservation and emission reduction benefits.

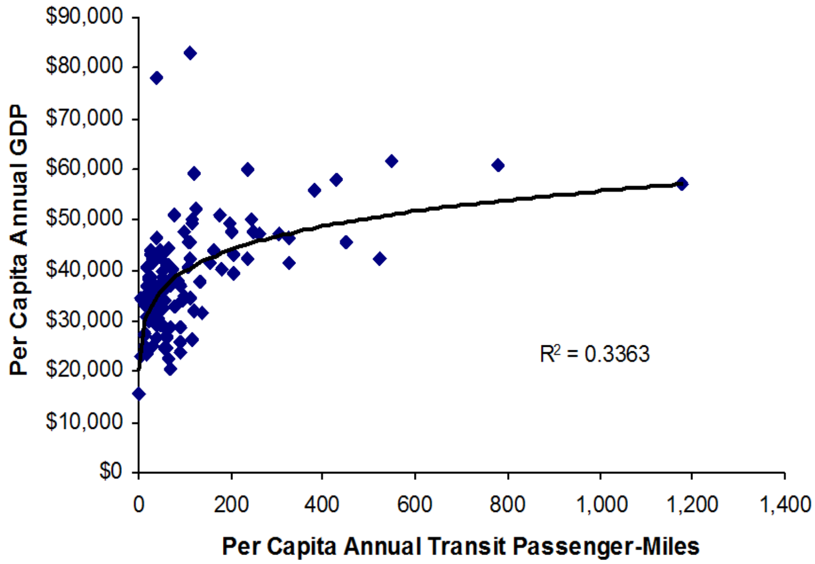
Improved Transit System Performance
High quality transit systems tend to perform better than basic bus systems according to most indicators including system coverage (number of destinations or jobs that can be reached within a given travel time), per capita transit ridership and mode share, travel speed, cost efficiency (cost per passenger-mile or –trip) and cost recovery (portion of total costs borne by fares). This is not to criticize bus transit, which tends to operate in mixed traffic and serves times and places with lower transit demands, rather, this illustrates the potential performance gains that can be achieved with higher quality transit and Transit Oriented Development that increases operating efficiency and ridership. This indicates that critics are wrong to argue that bus transit is more efficient and cost effective than rail; where there is sufficient potential demand, rail tends to have better overall performance.

Strategic Development Goals
By providing a catalyst for more compact, multimodal neighborhoods, high quality public transit can help achieve strategic development goals including openspace and cultural preservation, reduces public infrastructure savings, improved accessibility (particularly for non-drivers), improved affordability, and local economic development.

Economic Development
High quality transit and Transit Oriented Development tend to support economic development (increased productivity, employment, property values, tax revenue, etc.) by creating more compact and connected development which provides agglomeration efficiencies, expands businesses' employment pool, shifts household expenditures from vehicles and fuel to more locally-produced goods, and supports industries such as tourism, higher education and retirement services (Litman 2017; Weisbrod, et al. 2017).

Transit Oriented Development tends to significantly increase local property values, typically by 5-20%, reflecting the capitalized value of transportation cost savings and the increased productivity in more compact and connected communities (Smith and Gihring 2004). This, in turn, tends to increase local businesses and property tax revenues. Economists Hsieh and Moretti (2017) predict that more high-quality transit and more compact development in high productivity cities would significantly increase national productivity. EDRG (2007) estimate that Chicago region transit improvements provide an 21% annual return on investment, an enhanced plan would provide a 34% return, and more TOD, could increase these returns to 61%. Figure 23 indicates that Gross Domestic Product (GDP) tends to increase with per capita transit travel, providing empirical evidence of high quality transit's economic benefits.

Figure 23 **Per Capita GDP and Transit Ridership** (Bureau of Economic Accounts)



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

Transit Benefits Summary

Table 5 summarizes benefits of public transit and Transit Oriented Developments.

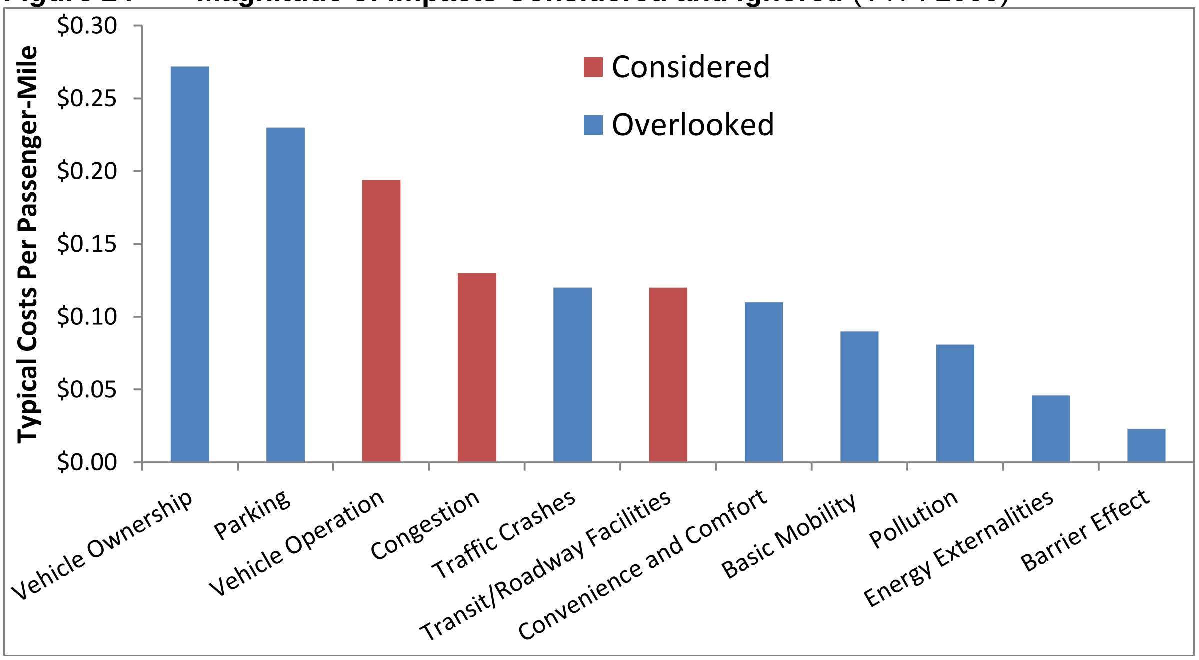
Table 5 **High Quality Transit and TOD Benefits** (Litman 2017; Weisbrod, et al. 2017)

Mobility Benefits	Efficiency Benefits	Land Use Impacts
Benefits from improving mobility options for non-drivers	Benefits from reduced automobile travel	Benefits from more compact, transit-oriented development
Improved transit passenger convenience and comfort Improved mobility and economic opportunity for non-drivers Equity objectives (benefits disadvantaged groups) Option value	Reduced traffic and parking congestion Road and parking facility cost savings Vehicle cost savings Reduced chauffeuring burdens Traffic safety Public fitness and health Energy conservation and emission reductions	Improved accessibility Preserves openspace and reduces costs of providing public infrastructure and services Agglomeration efficiencies increase economic productivity Increased local property values and tax revenues

Public transit can provide numerous direct and indirect benefits. Critics tend to undervalue these benefits.

Conventional transportation evaluation, such as the benefit/cost models commonly used to evaluate roadway and transit investments, and the analysis frameworks typically used by critics, overlook many of these benefits. They generally consider congestion, public facility and service costs, and vehicle operating costs, but ignore or undervalue vehicle ownership, parking, crash, pollution,[1] energy externalities and barrier effect (delays that wider roads and increased vehicle traffic cause to pedestrians) costs, the values of increased transit convenience and comfort, and of improved mobility for non-drivers provided by high quality public transit, although these impacts are significant in magnitude compared with impacts that are considered.

Figure 24 **Magnitude of Impacts Considered and Ignored** (VTPI 2009)



Critics overlook many of the largest benefits of high quality transit and Transit Oriented Development.

Admittedly, these impacts can be difficult to measure, and vary depending on conditions. For example, Transit Oriented Development residents tend to own about half as many vehicles and spend far less in total on transportation than peers living in automobile–oriented areas (Arrington, et al. 2008), indicating that high quality transit and TOD allow many households to save thousands of dollars annually in vehicle ownership and parking costs, but it can be difficult to predict the magnitude of these savings for a new transit service or development. However, such uncertainty does not justify ignoring these impacts, as critics generally do; comprehensive and objective analysis discusses these benefits and addresses uncertainty by estimating upper- and lower-bound values. To the degree that there is growing consumer demand for living in compact and multimodal urban neighborhoods, these benefits should be particularly large.

[1] If conventional cost studies consider crash and pollution emissions at all they are generally measured per passenger-mile, which ignores the additional crash and emission reductions that high quality transit and TOD tend to leverage by reducing total per capita vehicle travel.

Evaluating Specific Critics

This section evaluates specific transit critics. Also see CFTE (2005), Parry and Small (2007) and Walker (2016). These critics tend to fall into two major categories: Some are economists who apply narrow benefit/cost models to transit investments. The second are associated with various pseudo-free-market advocacy organizations, such as the Reason Foundation and the Cato Institute, which favor private over public infrastructure and tend to oppose strategic planning. They can be considered "pseudo" free market advocates because they oppose transit subsidies, but with few exceptions (Shoup 2011) fail to oppose much larger automobile subsidies, such as unpriced roads and parking.

The Great Train Robbery

The Great Train Robbery: Urban Transportation in the 21st Century, by Wendell Cox and Joel Kotkin (2017) argues that urban rail is costly, ineffective and unfair. It reflects many of the inaccuracies and biases previously described in this report.

Cox and Kotkin's basic thesis is that outside a few "legacy" transit-oriented cities with dense central areas, rail transit is outdated and wasteful. They argue that the automobile dependency and sprawl are inevitable, efficient and desirable, which ignores growing demand for alternative modes and more compact and accessible neighborhoods (NAR 2015), and the inefficiencies of automobile dependency. They assume that development patterns are static, which ignores efforts by many suburbs to become more compact and multimodal; in fact, many of the greatest beneficiaries of rail system expansions are suburbs such as Lakewood outside Denver, Silver Springs outside Washington D.C. and Walnut Creek outside of San Francisco.

To make transit investments appear ineffective Cox and Kotkin report total government spending on public transit over a 45 year period, which is a large but meaningless number (more than one trillion dollars). They argue that, "New urban rail systems have been exorbitantly expensive," but compared with what? Useful analysis measures transit investments per capita, and compares transit investments with the full costs of automobile travel under the same conditions, including expenditures on roads, parking facilities, vehicles, fuel, and for travellers who lack a driver's license, the costs of a paid driver.

Cox and Kotkin cherry pick examples, including cities with relatively small and new rail transit systems, such as Houston and Phoenix, and ignore cities with larger and more successful rail systems such as Calgary, Charlotte, Minneapolis-St. Paul, Portland and Seattle (Freemark 2014a). They criticize Houston and Phoenix rail systems for failing to transform regional travel patterns, although they only serve a small portion of total regional travel. To make rail transit investments seem ineffective they report declines in regional transit mode shares, but fail to compare travel patterns in cities and travel corridors with and without rail; as previously described, many studies indicate that transit ridership tends to increase as rail transit networks expand, and cities with large rail networks have far better performance (transit ridership and cost efficiency, transportation affordability and traffic safety) than more automobile dependent cities (CTS 2013; Litman 2005; Renne 2005). They argue that Los Angeles urban rail cannot be effective because only 2% of regional employment is downtown, but they fail to report the portion of jobs located in areas served by rail, now and in the future. They criticize Houston's rail investments for being ineffective and expensive, although it carries 60,600 average weekday trips, equivalent to approximately 10 highway traffic lanes (assuming 6,000 peak-period vehicles per lane), and cost a fraction of regional expenditures on vehicles, parking and highways.

Cox and Kotkin only consider a few benefits of high quality transit; they ignore consumer savings and affordability, parking cost savings, improved mobility and increased economic opportunity for non-drivers, reduced chauffeuring burdens, traffic safety, improved public fitness and health, local economic development, and support for other strategic planning objectives. They report evidence indicating that rail transit is an ineffective congestion reduction strategy, but ignore a large body of previously described research indicating that high-quality, grade-separated transit tends to reduce per capita congestion delays.

Many of Cox and Kotkin's arguments assume that current conditions are optimal and reflect consumer preferences; they ignore the possibility that some travellers would prefer to drive less and rely more on transit, if it were more convenient and comfortable, or that some households would prefer to live in Transit Oriented Developments, if they were more abundant and affordable. Similarly, they cite high automobile commuting rates by lower-income workers as evidence that public transit is ineffective, but this could be interpreted as evidence of the need for public transit improvements so lower-income workers have more affordable travel options.

The solutions Cox and Kotkin propose would often be ineffective and contradictory. For example, they recommend subsidizing automobile ownership to improve mobility for disadvantaged groups, although that is not useful to travellers who lack driver's licenses, and that would increase traffic congestion, parking problems, accidents and pollution emissions.

Cox and Kotkin conclude, "…from a public policy perspective, it seems unwise to spend money on additional options for people who can make their way to work on their own. A better approach would be to focus on developing cost-effective new options for those who lack the mobility to reach jobs." This assumes that rail investments always reduce bus service funding, and that rail transit and Transit Oriented Development provide no benefit to transit-dependent travellers. Neither assumption is necessarily true: most rail transit funds are ether shifted from highway accounts or new revenues specifically for higher-quality transit, and many poor people benefit from high quality service provided by rail, and from the many benefits of TOD.

Although this report is published by a university, it fails to reflect academic research standards: it lacks peer review, a statement of funding sources, or a declaration of conflicting interests.

Critiquing Specific Statements

Transit advocacy "*has been effective in raising transit spending, with more than $1 trillion in government subsidy expenditures in the United States since 1970.*" This is an old propaganda trick: they create a very large number to make public transit seem expensive. This is a 45 year total; you could also say that transit spending averages about $22 billion annually, which is about 15% of total roadway spending, $88 annual or 25¢ per day per person, about 2% of consumer spending on motor vehicles, or a very tiny amount compared with total spending by households, business and governments on vehicles, fuel, roads and parking facilities to accommodate personal automobile travel.

"Critically, many of these new transit lines have not reduced the percentage of those who commute alone by car" The accuracy of this claim depends on the scale of analysis. Most new high-quality transit lines do significantly increase transit ridership and reduce automobile commuting (Boarnet and Houston 2013; CTS 2013; Ewing, Tian and Spain 2014), and most TODs

have lower automobile commute mode shares and automobile trip generation rates than other areas (Arrington, et al. 2008), so it is a false statement if applied to affected corridors or areas, but a single new transit line or TOD affects too small a large portion of regional travel to be measurable at a regional scale. However, as previously described, per capita transit ridership rates tend to increase and automobile mode shares decline as rail transit systems expand in an urban region (Renne 2005).

"Soon, urban mobility may be further transformed, and perhaps enhanced, by new technologies. These include the continuing development of smart phones and ride hailing and sharing services, and ultimately of the autonomous car." Yes, but many of these new technologies support and are supported by high quality transit. For example, smart phone navigation and payment systems facilitate transit use, and ride-hailing services are more costly and space intensive (they do not reduce traffic congestion) than transit, and so are best used as public transit services access modes. Many urban residents prefer transit so they can rest or use electronic devices while commuting. Autonomous vehicles can increase total vehicle travel and therefore traffic congestion, increasing the importance of high quality transit on urban corridors (Schmitt 2016).

"*Boosting programs that assist car ownership, home based work, and ridesharing services could all provide more effective and affordable alternatives to traditional transit in most cities.*" This is often untrue. Many transit passengers cannot drive. Home based work and ridesharing are unsuitable for many trips, jobs and workers, particularly lower-wage service jobs. Programs to assist car ownership by lower-income households increase many direct and indirect costs. Even a free vehicle is costly, including insurance, registration, maintenance, and sometimes large and unexpected repairs, and the resulting increases in vehicle travel increase traffic and parking congestion, accident risk and pollution emissions. When all costs are considered, improving public transit service is often more cost effective overall.

"*The National Household Travel Survey for 2009 found that respondents who said that they had commuted by transit on the day of the survey also said that they used transit only 68 percent of the time. This would imply a national transit journey to work market share of about 3.5 percent.*" Conversely, some people who normally commute by auto occasionally commute by transit. Since auto commute mode share is so large, a small number of occasional users would significant increase total transit commuting.

"*TRANSIT IS ABOUT THE CBD AND URBAN CORE*" This statement is wrong. Public transit plays many roles in an efficient and equitable transport system, including basic mobility for non-drivers and efficient travel on urban corridors. Urban rail systems serve numerous destinations, including downtowns and other large commercial centers, college and university campuses, conference and sports centers, residential neighborhoods and transportation terminals. These areas are experiencing rapid employment growth (Cortright 2015), and have significant traffic and parking congestion; this combination justifies high quality transit to support growth and reduce traffic and parking problems. Cox and Kotkin's arguments are outdated.

Analyzes New York employment trends between 1959 and 2014. That is an inappropriate time period for evaluating current travel trends and future transit demands. It would be better to focus on the last two decade when North American cities, particularly New York, experienced major employment and population growth.

"*In reality, the rail investments in these cities have made virtually no progress in attracting drivers from cars on to transit.*" On the contrary, previously descried research indicates that new rail transit systems have experienced significant ridership growth (Boarnet and Houston 2013; CNT 2013; CTS 2013; Henry and Litman 2006; Schumann 2005; Freemark 2014a and 2014b).

"*Among the 19 metropolitan areas that have opened substantially new urban rail systems since 1980, transit's share of work trips has declined on average from 4.7 percent to 4.6 percent, and remains less than the national average of 5.2 per cent.*" These cities started with low transit ridership, and this ridership declined less than in cities that lack rail (Freemark 2014a).

"*New urban rail systems have been exorbitantly expensive, but clearly have not reduced solo driving.*" This statement is hyperbole and inaccurate. As previously descried, rail projects are not expensive compared with the full costs (including expansion of urban highways and parking facilities, plus vehicle ownership and operating expenses) of accommodating more peak-period auto trips on the same corridors, and there is abundant evidence that these transit systems significantly increase transit ridership and reduce car travel on affected corridors. If critics consider rail project impacts inadequate, then they should advocate rail program expansion.

"Advocates in Phoenix, like those in many other cities, claimed light rail would introduce a whole new type of development, one that would appeal to both working millennials and retired 'snowbirds'. However, the results there, as elsewhere, have proven less than strongly transformative." This statement is vague. Transformation takes time. There are many examples of successful TOD.

"*All of this is despite a taxpayer bill of more than $1.5 billion for light rail*." $1.5 billion is a small investment compared with total highway, parking facility, vehicle ownership and operation expenditures for travel through downtown Houston. Any analysis should consider all benefits, costs and strategic impacts. A single light rail line may have small impacts on total regional travel, but that does not mean that the project is a poor investment and that Houston couldn't benefit from a more extensive rail transit network and more Transit Oriented Development.

"*Portland opened its MAX light rail system in 1986, but, despite that, has seen its transit market share drop from 7.9 percent in 1980 to 6.9 percent in 2015, only modestly above the national transit work trip market share.*" Such regional data hides the much higher transit mode shares along the rail corridor and in TODs. This decline is much smaller than peer cities that did not develop rail transit. Portland regional transit investments and land use policies have significantly reduced per capita vehicle travel compared with the national average, providing direct and indirect (Cortright 2010).

"*This will not be improved, contrary to conventional wisdom, since cities continue to disperse as more people move to less transit oriented areas. These realities rarely appear in discussions about transit, but need to shape policy in most metropolitan areas.*" This statement is inaccurate. Conventional wisdom continues to support automobile oriented planning, such as dedicated highway funding which encourages planners to expand roadways and mandate parking facilities, and provides less funding and greater economic review for transit than for highway projects. Many cities are now experiencing significant infill development, increasing transit demand, and this issue does widely appear in discussions about transit, which is why there is so much emphasis on transit-oriented development.

"*Surveys of where people want to live in five years show a decline in the number of those who prefer urban living, already a small minority, and an increase in desire to move to more rural areas.*" This is a selective and incomplete summary of consumer housing preference research. In fact, consumer surveys indicate that a growing portion of households want to live in more accessible and multimodal neighborhoods, as indicated by high housing prices in such areas. In response, many suburbs now support more compact, multimodal development (NAR 2015).

"*In most cities with legacy cores and in those without them, population and job growth is greatest in the suburbs and exurbs.*" This statement is outdated. In fact, cities are experiencing a greater share of population and job growth, and many suburbs are urbanizing, particularly around rail transit stations (Cortright 2015).

"*Travel times for commuters who use transit also are considerably longer than the travel times of those who drive alone or use car pools.*" Yes, transit commuting is generally slower than driving due to access and waiting time, but such comparisons are unfair because these data include many transit-dependent commuters who *must* use transit despite long trip durations, and some long-distance commuters. Because it is inexpensive to use, transit often has a faster *effective speed* (travel time plus time required to earn money to pay for travel) than driving. Many commuters prefer traveling by high quality transit, because passengers can use the time productively. Improving transit service allows commuters to use transit when it is most efficient and cost effective overall, considering all costs.

"*Despite this, even most commuters below the poverty line use cars to get to work.*" This shows inadequate transit services in most cities; it proves nothing about the potential savings and benefits that higher quality transit services could provide to low-income residents. In fact, where high quality transit exists, many lower-income residents use it (CTS 2010). Public transit service improvements can help lower-income residents by providing more convenient and affordable transport options.

"*Rather than viewing vehicle access as a burden to the low-income population, it should be recognized as a tool of access to a greater share of jobs and other opportunities.*" This ignores the high cost of automobile ownership. Although auto access tends to increase work hours and incomes, all of the additional income must be spent on the additional vehicle expenses (Smart and Klein 2015). As a result, lower-income residents benefit more transportation improvements that allow them to rely on public transit than automobile-oriented planning which forces them to rely on automobiles.

"*Research by the Progressive Policy Institute, a research organization affiliated with the Democratic Leadership Council, also has noted that 'The shortest distance between a poor person and a job is along a line driven in a car.'*" These citations are old (1999 and 2003) and fail to consider vehicle ownership cost burdens. Smart and Klein (2015) found that, although lower income workers tend to earn more if they have access to a car, on average all of the additional income must be spent to their additional transportation expenses, leaving them no better off financially overall. This and other research indicates that lower-income households can benefit more if they can commute efficiently by public transit.

"*Finally, there is more potential for working at home, which has increased substantially.*" Working at home is only suitable for certain jobs – generally not for lower-wage service jobs. It is not a practical substitute for public transit service improvements.

"*Regional planning agencies view future transit needs on a long-term basis, such as 25 years. However, the need of those in poverty is for employment now. It would seem more socially responsible to provide access to personal transportation for this population, thus improving employment opportunities and reducing poverty.*" The authors imply that the debate is between bus and rail investment, but the actual debate is often between highway and rail investments. Certainly, it is appropriate to consider all types of transportation improvements, including flexible mobility services, but if cities are investing in any durable transportation facilities (roads, parking, transit) it is appropriate to consider rail transit and transit-oriented development.

"*This is far more socially responsible than adding expensive services such as urban rail that have shown virtually no evidence of reducing driving alone.*" As previously described, this statement is untrue. Compared with cities that invest in bus transit, those that developed rail had larger transit ridership gains or smaller transit ridership declines.

"*Transit can best contribute to individual lives and the overall good of society by focusing on basic mobility for those who need it most.*" This focuses on one role of transit, but ignores others. Basic mobility for non-drivers is important, but high quality transit and TOD provide other large benefits, including improved passenger convenience and comfort, consumer savings, parking cost savings, traffic safety, improved public fitness and health, and support for more compact and economically productive urban development. Funding for urban rail and BRT systems is generally money that would otherwise be spend on highways, or is new funding, so it is wrong to assume that urban rail investments reduce basic transit services, in fact, urban regions with large rail transit systems also tend to have higher per capita bus transit supply and ridership than more automobile-oriented regions since they complement each other.

Light Rail Boon or Boondoggle

The article *Light Rail: Boon or Boondoggle* by economists Molly D. Castelazo and Thomas A. Garrett (2004) and a related report Garrett (2004) argue that automobile investments are more cost effective than light rail. However, their analysis is incomplete and biased.

Castelazo and Garrett argue that because transit is subsidized it fails to reflect consumer willingness-to-pay, and therefore net social welfare. This ignores the underpricing of automobile travel, including the costs of roads, parking, congestion, accidents and environmental damages not borne directly by users (Litman 2009; Ricardo-AEA 2014). This underpricing is particularly large under urban-peak conditions while transit subsidies tend to be lowest under such conditions due to higher load factors. As a result, transit subsidies can be considered a second-best solution to automobile underpricing.

Castelazo and Garrett claim that light rail can only provide short-term congestion and pollution reduction benefits. This is untrue and indicates that they are unfamiliar with the issue. As described earlier, there is both theoretical and empirical evidence that high-quality rail transit can provide significant, long-term reductions in per capita congestion costs. This is not to suggest that the pricing reforms Castelazo and Garrett recommend are unjustified. Like most economists, I agree that more efficient transportation pricing can help solve many problems. Since rail transit experiences significant economies of scale (increased ridership reduces unit costs, more optimal pricing should increase its cost-effectiveness, reducing costs per passenger-mile and cost recovery rates. Conversely, efficient pricing of road use is likely to be more politically acceptable and effective if implemented in conjunction with transit service improvements. The better the travel alternatives available, the smaller the price needed to reduce vehicle use to an economically optimal level (i.e., the greater the elasticity of automobile travel to pricing), and so the smaller the cost imposed on both those who reduce their automobile travel and those who continue to drive. In other words, pricing and transit investments are complements, not substitutes.

Comparing Transit and Automobile Costs

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

Castelazo and Garrett claim incorrectly that rail is more costly than bus transit. Under some circumstances rail has lower costs than bus transit (Litman 2005). They claim that light rail operating costs average 54¢ per passenger-mile, reflecting national cost values, but this includes many new light rail systems that are still building ridership and so have relatively high costs per passenger-mile. In St. Louis light rail costs actually average 27¢ per passenger-mile, less than a third of the 82¢ per passenger-mile for bus transit services (APTA, 2002). Buses tend to be more cost effective in areas with low demand, but rail is often more cost effective than either automobile or bus transit in the dense urban corridors where rail is usually implemented.

On congested urban corridors automobile travel often costs two or three times more than the 41.4¢ per passenger-mile Castelazo and Garrett assume. As described earlier, the cost of an automobile trip includes vehicle expenses, 10-50¢ per vehicle-mile for urban road capacity and congestion impacts, $5-15 per day for downtown parking (averaging 25-75¢ per vehicle-mile for a 20-mile round trip commute), plus 1-10¢ per vehicle-mile for pollution emissions (Litman 2005; Ricardo-AEA 2014). This indicates that automobile travel on these corridors costs $0.77 to $1.76 per mile, far higher than light rail transit costs on the same corridor.

Transit services, particularly rail transit, tend to experience economies of scale. If transit service is needed to provide basic mobility to non-drivers, the marginal cost of accommodating additional riders is often small. For this reason, high costs per passenger-mile can be reduced with incentives such as road and parking pricing, commute trip reduction programs and fare subsidies that increase ridership and reduce unit costs.

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

Providing Mobility for Non-drivers

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

First, transit is subsidized for several reasons besides providing mobility to lower-income travelers. If transit subsidies were eliminated and the money used to purchase cars for the 14% of transit riders Castelazo and Garrett consider low-income, other transport problems would increase, and the 86% of current transit riders who do not qualify would be worse off.

Second, many transit riders cannot or should not drive. Subsidizing car ownership would not serve their mobility needs, or could increase higher-risk driving. Third, substituting car ownership for transit service is more expensive than they assume. Eliminating scheduled transit service would force riders who cannot drive to use demand-response or taxi services, which have far higher costs.

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

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

Fifth, there are substantial practical problems to subsidizing cars or carsharing instead of transit services. Castelazo and Garrett apparently assume that the 7,700 rail transit riders they identify as being unable to afford a car are a distinct, identifiable group. In fact, they consist of a much larger group, many of whom use transit part-time or occasionally lack access to a car. For example, non-car owning riders may consist of 3,000 daily transit users, 4,000 who use it half-time, 10,000 who use it an average of once a week, and 700 out of town visitors. As a result, rather than giving 7,700 households a car, it would be necessary to offer a much larger number of households a part-time car, with provisions that account for constant changes in vehicle ownership and travel status, and for the increased travel that occurs when non-drivers gain access to an automobile. Like any subsidy program, it would face substantial administrative costs and require complex rules to determine who receives a subsidy, and how much they receive, in a way that seems fair and effective at achieving its objectives. It would create perverse incentives, rewarding poverty and automobile dependency.

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

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

The Social Desirability of Urban Rail Transit Systems

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

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

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

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

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

Washington's War on Cars and the Suburbs

A paper by Wendell Cox (2010) titled, *Washington's War on Cars and the Suburbs: Secretary LaHood's False Claims on Roads and Transit*, criticizes USDOT rail transit investment plans, claiming that rail transit benefits are unproven and exaggerated. It criticizes my report, *Rail Transit in America: Comprehensive Evaluation of Benefits* (Litman 2005), the source of many of the Secretary's assertions. Cox's criticisms are evaluated below (Litman 2011)

Insufficiently Vetted and Outdated?

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

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

A War on Cars and Suburbs?

Cox is wrong to suggest that the USDOT's policies represent a *war* on automobiles and suburbs. Rail transit and smart growth policies do not harm motorists; as previously described, motorists often benefit overall from reduced congestion, accident risk and chauffeuring burdens. Similarly, many suburbs benefit from rail services and smart growth policies. Even with USDOT policy changes, the majority of federal transportation planning and investment resources are devoted to highways.[2]

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

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

[2] Transit funding has remained at about 20% of federal transportation expenditures for more than two decades and funding for *enhancements*, which includes non-motorized facilities and various other projects, receives less than 5%. For information see the "Finance" section of the *FHWA Highway Statistics* reports.

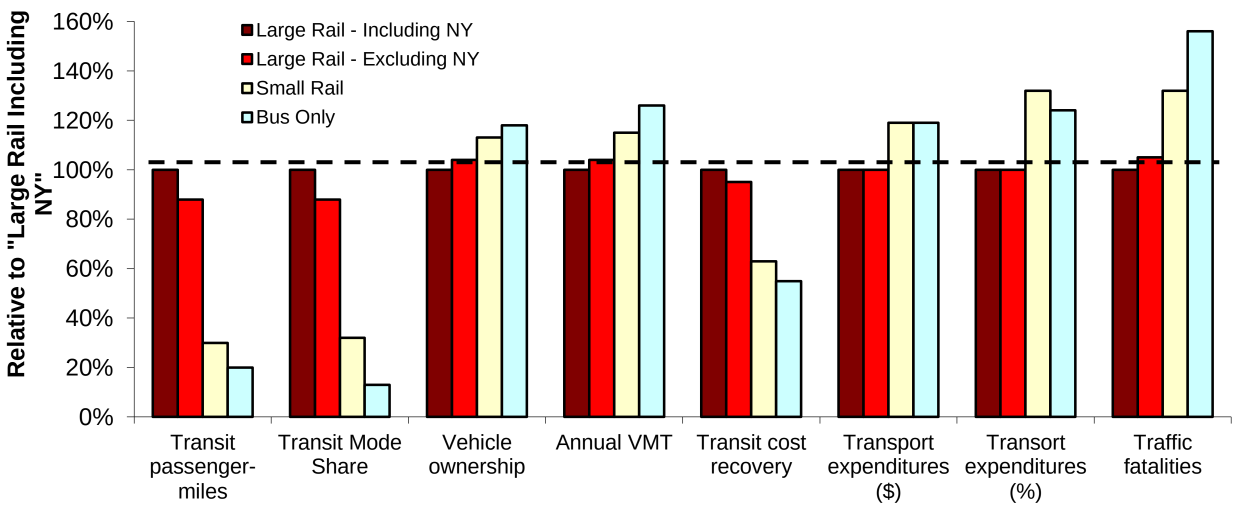
Analysis Methodology

Cox argues that, "The APTA report sets up a 'straw man' to suggest how costs would differ in urban areas if rail transit service did not exist." This is wrong. *Rail Transit in America* compares actual transportation system performance between U.S. cities with and without high quality rail using standard statistics such as congestion costs, accident rates, consumer spending and transit cost recovery. It does not speculate on how such impacts would change in particular cities if rail service did not exist.

New York City's Influence

Cox argues, "APTA's large-rail urban-area classification is principally a measure of rail's impact in New York City (not the New York urban or metropolitan areas) rather than in large-rail urban areas outside New York." This is untrue. Because critics made this claim, soon after *Rail Transit in America* was released I reanalyzed the data excluding New York and published the results in subsequent report versions. The results, summarized in Figure 25 indicate that in no case does including New York significantly affect results and conclusions. With and without New York, the "Large Rail" cities experience substantially higher transit ridership and cost recovery, reduced vehicle ownership and mileage, substantial consumer savings, and much lower traffic fatalities.

Figure 25 **New York Impacts on Analysis Results** (Litman 2005)



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

Geographic Definitions

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

It is true that statistics used in *Rail Transit in America* vary geographically. For example, FHWA *Urban Areas* differ from U.S. Census *Metropolitan Statistical Areas*, which differ from FTA *Transit Service Areas*. However, these differences are indicated in the report. Cox is correct that in some cases it would be more accurate to use the term *metropolitan region* rather than *city*, but the word *city* is often used for metropolitan regions, for example, in the Texas

Transportation Institute's *Urban Mobility Study*. As Cox points out, the study uses *core municipality transit mode share* to categorize cities' rail quality, but this makes sense since rail service is concentrated in central areas. Using regional instead of central city mode share would not change the resulting categorizations so the criticism is irrelevant.

Economic Impacts

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

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

Consider the impacts in San Antonio, as Cox does. In 2005, U.S. consumers spent an average of $3,500 annual on vehicles and fuel (BLS 2007), or about $7.0 billion annually for the region. If high quality transit can reduce these expenses 20%, as in other urban regions, the $1.4 billion annual consumer savings would increase domestic employment by about 5,600 jobs, with larger gains at the regional level, and these benefits should in the future as petroleum prices rise. Of course, developing high quality transit service in San Antonio would require significant service improvements. Cox estimates that doubling San Antonio's transit ridership would require $150 million in additional annual expenditures, which seems large compared with current transit funding but is only 1-2% of current regional spending on vehicles (about $3,500 per capita, $7.0 billion total), roads (about $500 per capita, $1.0 billion total) and parking facilities (about $2,000+ per capita, $4.0 billion total).

Energy Conservation and Emission Reductions

Cox argues that rail provides only modest energy savings and emission reductions compared with driving a modern, fuel efficient car, based on comparisons of fuel consumption rates per passenger-mile. However, as previously discussed, this ignores the larger energy savings and emission reductions indicated by lifecycle analyses that account for upstream and embodied energy (Chester and Horvath 2008, see Figure 9 of this report), and the energy savings that result from reductions in total per capita vehicle travel. As described in the first section of this report, residents of transit-oriented communities typically drive 20-40% less than in automobile-dependent communities, and so consume that much less fuel (ICF 2008 and 2010).

Congestion Reduction, Accessibility and Economic Development

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

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

Consumer Savings

Cox criticizes *Rail Transit in America's* consumer spending analysis because it is based on the Bureau of Labor Statistic's *Consumer Expenditures Survey*. He relies instead on the *ACCRA Cost of Living Index*, which is designed to, "compare cost of living differences among urban areas based on the price of consumer goods and services *appropriate for professional and managerial households in the top income quintile*" [emphasis added]. That survey holds vehicle ownership constant and so ignores transportation costs savings in transit-oriented cities. Cox never mentions that his analysis is skewed to high income households and is therefore inappropriate for evaluating impacts on average households. This is either a significant oversight or an intentional misrepresentation.

Travel Time Costs, Consumer Preferences and Economic Productivity

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

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

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

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

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

- Although, as Cox points out, there is good evidence that improved employment access increase productivity, this applies equally to transit.[3]
- Although economically disadvantaged workers can benefit from access to a car, they also benefit from access to high quality public transit (Yi 2006).
- Many disadvantaged people physically or legally cannot drive, and those who can drive often choose high quality public transit, if available, to save money.
- As described previously, empirical evidence indicates that rail transit cities have higher per capita GDP than cities with lower quality transit, indicating that Cox is wrong.

Roadway Savings

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

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

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

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

Traffic Accident Costs[4]

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

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

Rail Versus Bus

Cox claims (footnote 4), "Oddly, it appears that a principal objective of the APTA report is to demonstrate the ineffectiveness of buses as a mode of transport. (footnote 4).
This is not true.[5] *Rail Transit in America* includes a section titled "Rail Versus Bus Transit" which discusses the advantages and disadvantages of each mode. It concludes:

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

Transit Cost Efficiency

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

[4] Cox is correct that the traffic fatally data was mislabeled, the correct source is the National Highway Traffic Safety Administration as published in Ewing, Pendall and Chen (2002), not FTA 2001.
[5] I am a strong supporter of bus transit improvements, particularly BRT. I contributed to the *Bus Rapid Transit Planning Guide* (www.itdp.org/index.php/microsite/brt_planning_guide).

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

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

Smart Growth Impacts on Housing Affordability

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

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

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

Summary

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

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

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

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

The Coming Transit Apocalypse (O'Toole 2017)

O'Toole argues that public transit is inefficient and "useless." Although he raises some legitimate issues to consider in transit planning, O'Toole's arguments reflect many of the omissions and biases previously discussed in this report.

O'Toole state, "With annual subsidies of $50 billion covering 76 percent of its costs, public transit may be the most heavily subsidized consumer-based industry in the country." That is untrue. In 2015 U.S. government agencies spent a total of $235 billion on roadways, of which $113 (48%) was from user fees (tolls, special fuel taxes and vehicle registration fees) and $122 billion are general tax subsidies (FHWA, 2017, Table HF-10). In addition, automobiles rely on huge parking subsidies: there are also between 3 and 8 government-mandated off-street parking spaces per motor vehicle, or between one and two billion in the U.S. (Chester, Horvath and Madanat 2010). Assuming that their total (including land, construction and operating) costs average $500-1,500 per space, this represents $622 billion to $3.1 trillion dollars in annualized subsidies for automobile-oriented infrastructure, 12 to 62 times the $50 billion public transit subsidies. Described differently, subsidies (costs not paid by direct user fees) pay 82-96% of motor vehicle infrastructure costs. Of course, costs and subsidies can be measured in various ways, but there is no doubt that roadway and government-mandated parking subsidies are many times larger than public transit subsidies.

O'Toole points out that low fuel prices helped reduced transit ridership in recent years, but fuel prices have stabilized and are unlikely to decline further. He state,

> "From 2014 to 2016, nationwide ridership declined by 4.4 percent. While this may seem small, some urban areas have seen catastrophic losses in riders in the past few years. Since 2009, transit ridership has fallen by 37 percent in Wichita, 36 percent in Memphis, 31 percent in Sacramento and Richmond, 29 percent in Detroit, 28 percent in Bakersfield and Toledo, and 27 percent in Fresno. Transit systems in Atlanta, Cincinnati, Los Angeles, Milwaukee, St. Louis, and Washington have all suffered double-digit declines since 2009."

This cherry-picks data. Yes, some transit systems experienced ridership declines, but others experienced ridership gains, due largely on local investment and planning practices: where transit service was improved ridership tended to increase as previously discussed and illustrated in Figures 5 and 6. As a result, O'Toole's arguments are backward; declining ridership justifies more support for public transit in order to achieve its potential benefits.

O'Toole argues that the industry faces a maintenance backlog "crisis," although the total estimated costs ($87 billion over two decades) represent about 5% of annual expenditures. Certainly, major reinvestments are needed to maintain and improve transit service, but this is not a crisis unless policy makers undervalue public transit investments.

O'Toole argues that many public transit agencies have excessive "unfunded" pension and healthcare obligations. Many public and private organizations fund employee pension and healthcare costs out of current budgets, which makes sense for stable organizations to minimize administration costs. To make these costs look large he compares total costs with annual operating expenses, which it equivalent to comparing an individual's total retirement savings with their annual income. In most cases they are approximately equal, indicating that these financial obligations represent less than a 5% annual cost over the next two decades, hardly a crisis, and a ratio that is similar or better than many major corporations (Durden 2016).

O'Toole also argues that ride-hailing services and autonomous vehicle technologies will soon eliminate the need for public transit, based on optimistic projections of their development speed, cost efficiency and benefits. As previously described, these technologies will probably take longer to develop, cost more, provide smaller benefits, and cause more problems than optimists acknowledge, and in some ways these technologies will increase the need for public transit. Ride hailing is already increasing traffic congestion (Schaller 2017), and by stimulating more driving autonomous vehicles can make the problems far worse. As a result, experts recommend that public policies encourage shared vehicles, that is, public transit, and use these new technologies and services to improve and encourage public transit services (RPA 2017; Shared Mobility Principles 2017).

Concerning transit investments in Los Angeles and Seattle O'Toole writes blithely, "Virtually all of this money will be wasted, especially since driverless cars will probably be on the streets of those cities before any of the light-rail lines funded by the new taxes will open." He does not explain how tens of thousands of rail transit riders can shift to driverless cars without overwhelming these cities' already congested urban highways. O'Toole is wrong to suggest that these new services reduce the need for public transit.

O'Toole bases his arguments on the assumption that the only significant role that public transit should play is to provide basic mobility for non-drivers, and so advocates basic services. He ignores other important benefits provided by high quality transit and transit oriented development including reduced traffic and parking congestion on major urban corridors, consumer savings and affordability (savings to lower-income households) from living in transit-oriented communities, increased traffic safety and health benefits, which often exceed transit investment costs.

Great Rail Disasters

Randal O'Toole published *Great Rail Disasters* in 2004 to support his criticism of rail transit investments and smart growth policies.[6] The report applies the author's thirteen component index of transit impacts. But this index fails to reflect best practices for transit evaluation. It makes a fundamental error by grouping together all cities with rail transit service, regardless of size. For example, it criticizes the New Orleans rail system for failing to solve the city's transport problems, although it is only a single rail line that serves a tiny portion of total regional transit trips. Accurate analysis must take into account the relative magnitude of rail systems.

O'Toole claims that rail fails to increase transit ridership, based on ridership trends between 1970 and 2000. But this indicates nothing about rail transit's effects since it includes no comparisons between cities or corridors with and without rail, or between rail cities and national trends. The only relevant evidence is the statement (which turns out to be false and has yet to be corrected) that,[7] "The twenty-three urban areas with rail transit collectively lost more than 33,000 transit commuters during the 1990s, while the twenty-five largest urban areas without rail transit collectively gained more than 27,000 transit commuters." These changes may reflect other factors unrelated to transit mode, such as the city's population and employment trends. Transit ridership grew in 18 of the 23 cities O'Toole analyzes, particularly those with expanding rail systems such as Denver (40%), Los Angeles (14%), Portland (59%), Sacramento (48%), San Jose (23%) and St. Louis (22%), indicating that rail transit investments often do increase ridership (also see, Winston and Langer 2004).

Several demographic and economic trends, including growing vehicle ownership, baby boomers reaching peak driving age, and declining transit service, increased automobile travel and reduced transit ridership between 1950s and the 1970s, but many of these trends have peaked, resulting in transit ridership growth since 1975 (Litman, 2005a). Declines in transit ridership were smaller in cities with rail systems (Baum-Snow and Kahn 2005).

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

[6] Subsequent rail critics such as Balaker (2004) rely heavily on O'Toole, citing him and his sources, and make many of the errors and misrepresentations described in this report.

[7] Randal O'Toole, the author of *Great Rail Disasters* was kind enough to send me his analysis spreadsheet for review. I found several substantial errors and reported them to him at the end of February 2004. He recalculated the data and adjusted the results downward, from a 33,000 commuter loss in rail cities and a 27,000 gain in bus cities, to a 14,097 loss in rail cities and a 1,388 gain in bus cities. Other values in the report will also need correction. Mr. O'Toole promised to correct these errors March 2004, but the reports posted on the Center for The American Dream website in 2005 still contain the false data.

O'Toole significantly underestimates urban roadway expansion costs because he uses average costs rather than the much higher costs of roadway projects in congested urban corridors where most rail transit systems are built, and ignores costs for planning, land acquisition, and intersections. Current large city highway expansion projects are typically two to four times higher than O'Toole's estimates (WSDOT 2004). He is also wrong to compare road and rail based on *total daily* rather than *peak period* travel, since most urban roadways can handle travel demand except during peak periods. Accordingly, roadway capacity expansion costs should be assigned only to peak-period travelers (Litman, 2008).

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

O'Toole argues that rail transit is dangerous based on relatively high crash rates per passenger-mile. Most of this risk is to other road users (pedestrians, cyclists and motorists), and it declines as load factors (transit passengers per vehicle) increase. Light rail crash rates per passenger-mile are far lower in other countries due to higher load factors and better integration of transit into urban design (Litman 2005). As with congestion, traffic accident risk is best measured *per capita* rather than per *passenger-mile*, since rail transit tends reduce total per capita vehicle travel. Various studies indicate that per capita traffic fatality rates decline with increased per capita transit ridership (Litman, 2008). U.S. cities with large rail systems average 7.5 traffic fatalities per 100,000 population (7.9 excluding New York), while cities with smaller rail systems average 9.9, and cities that lack rail average 11.7, a 40% higher rate (Litman 2005).

O'Toole argues that rail transit reduces transit service quality and so harms transit-dependent residents by absorbing an excessive portion of transit funding. However, per capita funding for both rail and bus transit tends to increase, and transit ridership grows, as rail transit systems expand, indicating that rail and bus transit are complements, not substitutes (Litman 2005). This occurs because rail transit tends to attract support from middle-class citizens, and so tends to increase total transit funding. In addition, transit-oriented development provides other benefits to non-drivers, including improved walking conditions and less-dispersed destinations that are easier to access without a car.

O'Toole claims that rail transit projects are consistently over-budget and have lower ridership than projected, based primarily on a study performed in the late 1980s that used even older examples (Pickrell 1989 and 1992).[8] Although many of the examples are two decades old, O'Toole uses the present tense when describing them (e.g., "Pickrell reports that it went 61 percent over budget and carries less than a third of the anticipated riders"). Even when it was first published Pickrell's report was considered dated since planning reforms had already corrected many of the problems identified (APTA, 1990). Similarly, O'Toole reports fourteen-year-old data on airport rail transit use by air travelers, and only when this number is low. O'Toole provides estimates of cost overruns and rider shortfalls for various rail projects but includes no details. Researchers normally provide specific references and analysis in a report to allow independent verification. O'Toole's failure to provide this information indicates either carelessness or that he has something to conceal.[9] O'Toole ignores examples of more recent transit projects that have been on-time, on-budget and exceeded their ridership projections, as described earlier (Table 3.

O'Toole claims that rail transit uses more energy than automobile travel, and is not cost-effective for reducing pollution emissions. However, he compares transit energy consumption with *cars* (3,500 BTUs per passenger-mile) rather than the *automobile fleet average* (6,348 BTUs per passenger-mile, including light trucks, SUVs and vans) which is either an error or an intentional attempt to deceive. He fails to account for rail's ability to reduce total per capita vehicle travel and therefore emissions (Litman 2005 and 2008). Although rail investments may not be justified on energy conservation and emission reductions alone, these can be considered valuable co-benefits. For example, if a community is choosing between expanding roadways or building rail in order to reduce traffic congestion, it makes sense to favor the rail option because it also reduces energy consumption and pollution emissions.

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

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

---

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

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

Summary: The Data Say Ouch!

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

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

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

- Lack of with-and-without analysis. There are virtually no comparisons between cities that have rail and those that do not. It is therefore impossible to identify rail transit impacts.
- Failing to differentiate between cities with relatively large, well-established rail systems and those with smaller and newer rail systems that carry a relatively small portion of regional transit ridership.
- Failing to compare individual city's trends with national trends.
- Failing to account for additional factors that affect transportation and urban development conditions, such as city size, changes in population and employment.
- Failing to apply marginal analysis. The report makes no effort to determine the incremental cost of accommodating additional peak-period travel by each mode.
- Ignoring many types of automobile costs. For example, vehicle expenses are included when calculating transit costs, but vehicle and parking expenses are ignored when calculating automobile costs.
- Exaggerating transit development costs. Claims, such as "Regions that emphasize rail transit typically spend 30 to 80 percent of their transportation capital budgets on transit" are unverified and generally only true for certain regions and years, not when costs are averaged over larger areas and times.
- Presenting outdated data as current, including examples from the 1960s through early 80's, and airport ridership data from 1990.
- Ignoring other benefits of rail transit such as parking cost savings, consumer cost savings and increased property values in areas with rail transit systems.
- Failing to apply current best practices in transit evaluation (Litman 2017).

Evaluating the Index

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

Table 7 Rail Transit Performance Index

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

This table recommends more appropriate indicators of transit system performance.

Point-Counter-Point with O'Toole

After an earlier version of this report was released, O'Toole sent me the following comments. My responses are in italics.

1. NEW YORK DISTORTS DATA

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Litman: *My goal is to create a comprehensive and accurate evaluation framework (see Litman 2005). Rail project budgets incorporate all associated costs. Buses require highways; and automobile travel requires vehicles, highways and parking facilities. It is inappropriate to compare rail capital costs with bus or highway costs without considering all vehicle, roadway and parking costs. I will incorporate capital costs in future analysis.*

5. HOUSING AFFORDABILITY DISCUSSION WRONG
The report says that "rail transit projects and smart growth policies are generally implemented in rapidly growing cities where property values are rising due to increasing demand." That is not necessarily true. The fastest growing cities in the U.S. have no rail transit and little smart-growth planning and their housing remains very affordable. It is only in cities such as San Jose and Portland, where planners have attempted to create a transit utopia by increasing population densities that housing prices have become dramatically unaffordable.

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

6. SAFETY DISCUSSION USES WRONG MEASURE

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

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

7. THE COST OF SPRAWL IS EXAGGERATED

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

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

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

Litman: *The evidence is quite mixed, and it misrepresents the issue to claim that it proves any single thing. People are diverse and at least some prefer urban living. Many cities are now experiencing population growth. Residents of Houston now support development of alternative travel options, including HOV lanes, bus transit, and recently rail transit systems, because they know from experience the problems that result from excessive dependency on automobiles, and therefore the benefits from a more diverse transportation system. This is not a question of urban versus suburban growth, rather, it is the nature of the growth that occurs since suburbs can be* *transit oriented.[10] Studies described in my paper indicate that many households are willing to pay a premium for New Urbanist housing and proximity to rail transit. Whether this market segment is a minority or a majority of consumers is irrelevant, as long as there is a sufficient demand (15-25% of urban households) it is large enough to support transit-oriented development.*

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

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

9. LACK OF REFERENCES A VALID CRITICISM

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

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

[10] Many suburban communities are developing into cities. Although such areas are classified as suburban, they enjoy significant benefits from rail transit as a catalyst for more efficient development patterns.

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

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

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

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

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

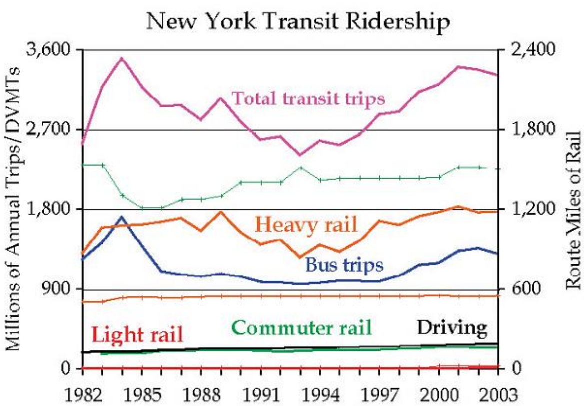
After hurricane Katrina stuck in August 2005, O'Toole recommended improving emergency response by shifting public transit funds to subsidize automobile ownership for lower-income households and highway expansion to accommodate larger traffic volumes. He argues that high rates of transit use and low vehicle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

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

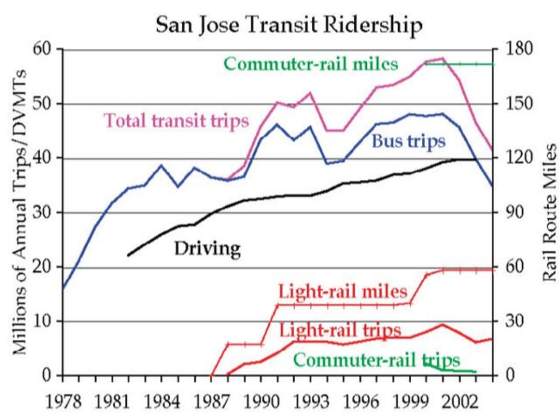
In 2005, O'Toole published an update of *Great Rail Disasters*, which evaluates the effectiveness of rail transit in terms of its ability to increase regional public transit ridership. This narrow focus on ridership appears to be in response to *Rail Transit in America* (Litman 2005), and the previous edition of this report, which showed that much of O'Toole's previous criticism of rail transit was inaccurate and misdirected.[11]

O'Toole's 2005 report rates various U.S. cities on a scale from A to F based on their transit ridership trends during the last two decades. This rating system is arbitrary and biased. It assigns an "F" rating to most rail cities, including many where total transit ridership is growing. It ignores positive ridership trends during the last decade (starting in the early 1990s) in cities such as Cleveland, San Francisco, St. Louis, New York and Atlanta. It claims that transit ridership is flat or declining in San Jose, California, although it more than doubled between 1980 and 2000 (Figure 26).

Figure 26 **O'Toole's Ridership Graphs**



O'Toole assigns New York an "F," claiming that transit ridership is flat. Yet ridership grew significantly between 1993 and 2001, and set new records in subsequent years.



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

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

[11] O'Toole references *Rail Transit In America* (Litman 2005), acknowledging that my study indicates that regions with high quality rail transit have higher per capita transit ridership and lower per capita congestion costs. He ignores other identified benefits such as reduced crashes, consumer cost savings and reduced operating costs per passenger-mile. It also misspells my name.

O'Toole compares rail regions with eight selected "Bus-Only" regions. The report does not explain why these particular cities were chosen, but they are all rapidly growing urban areas with high transit ridership growth. Many other "Bus-Only" regions lost transit ridership during this period. Matched pair analysis in Litman 2005 indicates that regions with large rail transit systems have much higher per capita transit ridership than similar size cities with smaller rail or bus-only transit systems.

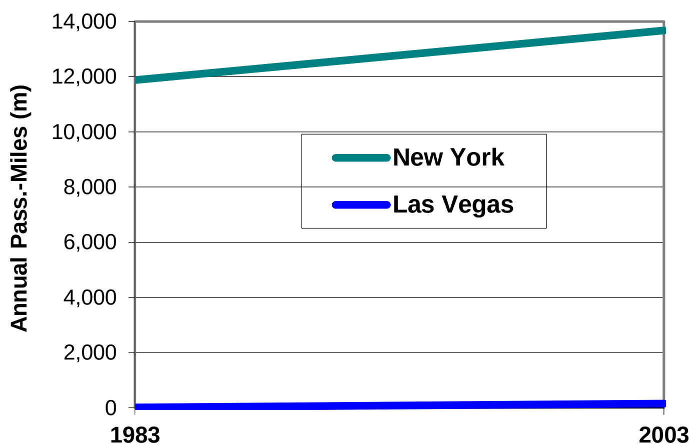
Table 8 **Change In Transit Ridership** (APTA Data)

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

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

For example, during the two-decade period transit ridership in Las Vegas (the selected city with the largest percentage ridership increase) grew tenfold, but population tripled, business boomed, and the city expanded to a size in which transit becomes increasingly important (Table 8). During the same period New York City transit ridership increased 15%, proportionately smaller but much larger than Las Vegas in absolute terms (Figure 27). Although Las Vegas annual ridership increased from 95 to 331 per capita passenger-miles, this is still small compared with New York's 1,707. At this growth rate it will take a century for Las Vegas residents to reach New York's current transit ridership.

Figure 27 **Total Transit Ridership Growth**



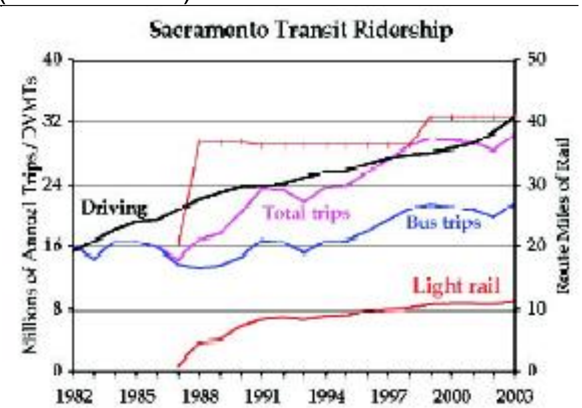
Transit ridership in Las Vegas (rated A) is small overall compared with New York (rated F).

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

O'Toole argues that buses are more cost-effective than rail at increasing transit ridership. As discussed earlier, this is usually untrue, particularly if rail is implemented with supportive land use policies. Total transit ridership (rail and bus) tends to increase in cities that have implemented new rail systems, as illustrated below, particularly if accompanied by supportive land use policies.

Figure 28 **Transit Ridership Increases** (O'Toole 2005)

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



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

O'Toole ignores the ability of rail to help achieve strategic planning objectives, such as more compact and multi-modal development that reduces per capita automobile ownership and use, providing economic, social and environmental benefits (Litman 2005 and 2008). It treats all transit passenger-miles equally, ignoring the fact that rail tends to operate in the densest corridors, where congestion, roadway and parking costs, and pollution impacts are highest, and so the benefits of reduced car travel are greatest.

O'Toole assumes that each region has a fixed transit budget, so money spent on rail transit reduces bus transit funding. This may be true under some circumstances in the short-term (such as the examples O'Toole describes), but in many situations rail funds would otherwise be spent on highways, and total per capita public transit funding tends to be higher in communities with rail transit systems (Litman 2005), indicating that rail and bus are complements rather than substitutes. This occurs because rail tends to generate public support for transit and provides a catalyst for more multi-modal travel, increasing use all types of transit. Over time, many regions with growing rail transit service also expand their bus services in response to growing demand.

O'Toole claims that transit is more dangerous than automobile travel, based on a comparison of fatality rates per passenger-mile and a few examples of new rail lines with high crash rates, such as Houston.[12] However, because rail transit tends to leverage overall reductions in per capita vehicle travel, per capita traffic fatalities and congestion costs tend to decline with increased rail transit service (Litman 2005 and 2008).

O'Toole argues that rail transit systems are inequitable, because they tend to serve higher-income commuters at the expense of lower-income, transit-dependent bus riders. This is not always true. Many rail systems are heavily used by middle and lower-income travelers. This criticism assumes that money spent on rail would otherwise be spent on bus transit, but as discussed earlier, rail expenditures often substitute for highway expenditures. By creating more accessible, multi-modal communities, rail transit tends to reduce consumer transportation costs, and improve accessibility for non-drivers and low-income travelers (Litman 2005).

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

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

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

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

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

A Desire Named Streetcar

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

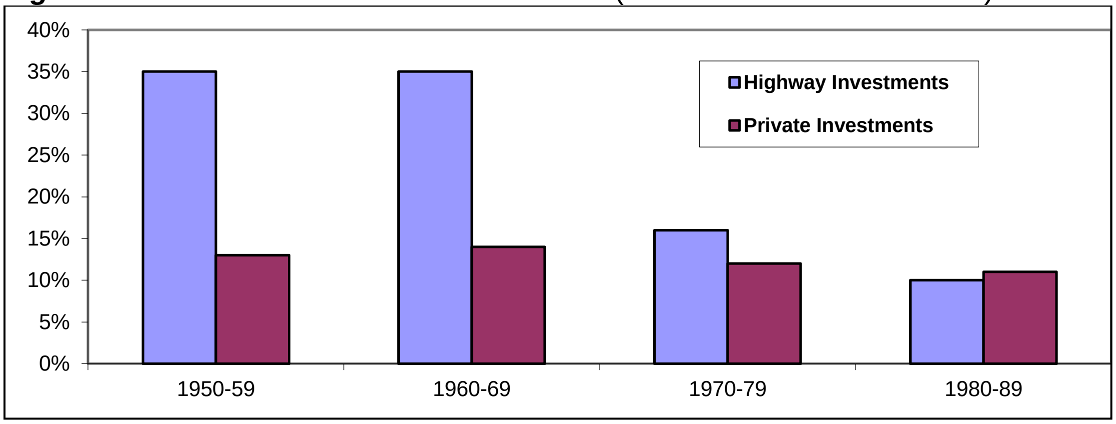
As described earlier, much of O'Toole's evidence that rail transit fails to attract riders is based on inaccurate and biased analysis. He also ignores many benefits of rail transit, such as parking cost savings, consumer cost savings and positive land use impacts. Analysis by Litman (2004) and Lewis and Williams (1999) show that, when all impacts are considered, rail transit benefits can exceed their incremental costs, indicating that rail transit investments can be cost effective overall. O'Toole does not discuss these issues; he assumes without question that rail transit investments are wasteful and irrational.

O'Toole claims that federal matching funds encourage wasteful rail transit investments, but the federal matching requirements are much higher for highways (often 90%) than for urban transit systems (usually 40-60%), requires less rigorous economic evaluation for highway projects than rail transit, and must compete for a much smaller portion of total transport funding (Beimborn and Puentes 2003). Because of the abundance of dedicated highway funds, most highway projects are financed through existing revenues while transit projects often require voters to approve new taxes. All of these create a much higher barrier for transit than highway projects.

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

O'Toole assumes that it would be more efficient and fair to invest in urban freeways than in rail transit. The economic return from highway expenditures has declined over time (Figure 29). Although highways showed high annual return on investment during the 1960s when the Interstate Highway System was developed, this has since declined significantly, and this decline is likely to continue since the most cost effective projects have been implemented. It therefore makes sense to invest less in roadways and more in public transit to maximize economic returns.

Figure 29 **Annual Return on Investment** (Nadiri and Mamuneas 1996)



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

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

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

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

Commuter Rail's False Promise

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

This misrepresents the analysis. In fact, Beaton found that in the Boston region, rail transit zones (areas within a 10-minute drive of commuter rail stations) had higher land use density, lower commercial property vacancy rates, and higher transit ridership than other areas. Regional transit ridership declined during the 1970s and 80s (it rebounded since 1990), but declined significantly less in rail zones, indicating that TOD increases ridership compared with what would otherwise occur. In 2000, transit mode split averaged 11-21% for rail zone residents, compared with 8% for the region overall. Areas where commuter rail stations closed during the 1970s retained relatively high transit ridership rates, indicating that the compact, mixed land use patterns that developed near these stations has a lasting legacy. Although Beaton found that land use density did not increase near stations built between 1970 and 1990, they did increase near stations build after 1990. This can be explained by the fact that the value of smart growth only became widely recognized in the 1990s, and much of the research and literature on transit oriented development is even more recent.

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

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

Appropriate Responses to Inaccurate Criticisms

High quality public transit provides diverse benefits, including many that are indirect and long-term. This is both a strength and a weakness. Critics exploit this diversity to create doubt and conflict: they attack urban rail intended to attract drivers as being unfair to poor people; they attack bus services intended to provide basic mobility for non-drivers for being slow and ineffective at reducing traffic problems; and they attack Transit Oriented Development for the long time required to transform communities and achieve its ultimate goals. Clever critics assemble facts and examples that support their attacks, and use this to sow division among potential allies, for example, pitting anti-poverty advocates against rail transit, creating doubt among motorists and environmentalists that transit improvements reduce congestion and emissions, and encouraging urban residents to oppose TOD as a threat to their community.

However, this diversity is also an opportunity. Advocates can apply more comprehensive analysis showing that, although transit is not necessarily the best way to achieve any *single* goal, it is often very cost effective considering all impacts. This diversity of benefits provides an opportunity to build coalitions in support of high quality transit and TOD based on shared goals.

Critics use various tricks to attack high quality transit and Transit Oriented Development, transit advocates can respond with more comprehensive and accurate information.

- To make transit demand seem small they report national or regional transit mode share statistics or ridership data without separating out areas with basic transit services, where ridership is declining, and areas with high quality transit, where ridership is growing, and they ignore evidence of significant latent demand for high quality transit and Transit Oriented Development.
- To make transit seem expensive they report the total of many years, or even decades of transit investments to produce a very large number. More accurate analysis reports annual per capita transit expenditures, and compares with total expenditures on automobile transportation, including roads, parking facilities, vehicles and fuel.
- To understate transit travel impacts they cherry pick examples, often cities with relatively small and new urban rail systems, and ignore cities that have developed larger, more integrated and more successful rail systems. They also ignore the superior performance (better service quality, higher per capita ridership and mode shares, lower operating costs per passenger-mile and trip, higher cost recovery) in transit-oriented cities. More accurate analysis considers a representative sample of transit systems and highlights those that are most efficient and improved.
- To underestimate the value of high quality transit they only consider a limited number of benefits, such as congestion or emission reductions, and ignore other important benefits including consumer savings and affordability, parking cost savings, improved mobility and increased economic opportunity for non-drivers, reduced chauffeuring burdens, reduced traffic accidents, improved public fitness and health, local economic development, and support for strategic planning objectives. Accurate analysis considers all of these benefits.
- To create conflicts between potential transit allies, critics argue that high quality transit does not benefit transit-dependent users, and assume that rail funding could otherwise be spent on basic bus services, although in many cases the money would otherwise be spent on roadways. In fact, many disadvantaged people use higher quality transit because it provides better (faster, more frequent, more comfortable and integrated) service, and cities with rail transit networks tend to have more bus services, since many transit passengers use both. More accurate analysis considers all impacts of high quality transit on disadvantaged residents, and builds coalitions to increase total public transit funding.

The table below summarizes various inaccurate or distorted criticisms and appropriate responses for more accurate and comprehensive analysis:

Table 9 **Common Transit Criticisms and Responses**

Criticisms	Appropriate Responses
Transit demand is declining.	Although demand is declining for lower-quality transit, it is increasing for higher quality service. Where service is improved, ridership tends to increase, and a significant portion of travellers cannot, should not, or prefer not to drive and so demand convenient and comfortable transit and TOD.
Transit fails to attract new riders and reduce auto travel.	Critics fail to account for service quality and ignore leverage effects. High quality transit can significantly reduce affected automobile ownership and use.
High quality transit is very expensive.	Critics exaggerate transit costs. Transit expenses should be reported per capita and compared with the total costs of accommodating automobile travel under the same conditions.
Transit investments are not cost effective.	Critics undervalue many transit benefits. When all impacts are considered, high quality transit is often very cost effective.
Transit does not reduce congestion or air pollution.	Critics use biased data. Good research indicates that high quality transit can significantly reduce congestion and emissions in affected areas.
Transit is slow and inefficient.	High quality transit can be relatively fast and time-competitive with driving. If available, travelers can choose transit when it is best overall.
Transit subsidies are unfair to motorists	Auto travel is highly subsidized, particularly on dense urban corridors. Transit investments ensure that non-drivers receive a fair share of public resources.
Transit is subsidized, automobile travel is not	Critics ignore many external costs of driving. Transit services are subsidized directly, automobile travel is subsidized indirectly by road and parking costs not borne directly by users, and various uncompensated external costs.
Rail transit harms poor people by reducing basic bus services	Poor people do use and benefit from high quality transit. Rail generates new transit funding and so need not reduce basic bus funding.

Many common criticisms misrepresent key issues and can be challenged.

The style of response depends on the context. In an academic or professional forum it may be appropriate to simply identify their misrepresentations and errors, and ways that they violate research quality standard such as peer review. In a political forum, it may also be useful to illustrate with vivid stories how underinvestment in public transit and undersupply of TOD housing harms individuals and communities, and to challenge critics on their conflicts of interest, for example, if they or their organizations are partly funded by automobile or petroleum industries.

Conclusions

There is good evidence of growing demand for high quality (fast, comfortable, and integrated) transit. Although few North Americans want to stop driving completely, surveys indicate that many would prefer to drive less and rely more on alternative modes, provided they are convenient, comfortable and safe. Serving this demand increases consumer welfare: if high quality service exists, travellers will use it when it makes them better off overall.

By providing attractive and efficient alternatives to urban driving, high quality transit and Transit Oriented Development tend to significantly increase transit ridership, reduce automobile ownership and use, and increase use of alternative modes, which provides many direct and indirect benefits including consumer savings and affordability, increased accessibility and economic opportunity for disadvantaged people (number of jobs and services accessible without an automobile), increased traffic safety and public health, reduced road and parking congestion and associated facility cost savings, energy conservation and emission reductions, improved public transit performance (cost efficiency and recovery), local economic development, and support for strategic development objectives. High quality transit helps achieve social equity goals: it ensures that people who for any reason cannot, should not, or prefer not to drive receive a fair share of transportation investment, and provides an affordable mobility option for physically, economically and socially disadvantaged people. Within affected areas, these impacts and benefits tend be large; their regional effects depend on the transit network quality and size, as these networks expand so do regional benefits.

Like any major public policy decision, public transit investments deserve fair and comprehensive evaluation of their benefits and costs. This can be challenging since many benefits of high quality transit are indirect, non-market and long-term, and so are difficult to predict with precision, but even using lower-bound benefit estimates, transit investments are often found to have high economic returns.

Transit improvement programs are often attacked by a small but vocal group of critics. Much of the critics' evidence is inaccurate. Their evidence tends to be biased in the following ways:

- Measure transit demand based on ridership in areas with poor service quality, ignoring latent demand for high quality transit and Transit Oriented Development.
- Use inappropriate scale, such as criticizing relatively small rail systems for failing to transform regional transport systems.
- Ignore significant transit benefit categories including improved user convenience and comfort, parking cost savings, consumer savings and affordability, improved mobility and economic opportunity for non-drivers, improved public safety and health and economic development.
- Ignore leverage effects that high quality transit and TOD often have on vehicle use.
- Ignore social equity goals and increased economic opportunity provided by high quality transit.
- Use outdated data and non-representative examples.
- Compare transit costs with just highway costs, ignoring other costs required by automobile travel including vehicles, fuel and parking facilities.
- Ignore research showing significant congestion reductions on corridors with high quality transit.

Public transit has three different and sometimes conflicting goals: providing basic mobility for non-drivers, efficient mobility on busy urban corridors, and a catalyst for more compact and multimodal development. The first tends to justify more dispersed service at times and places where demand is low, the second justifies high quality services concentrated on major urban corridors, and the third justifies projects that may initially seem costly because development impacts often take decades to fully mature. Critics exploit these differences: they attack rail projects for being unfair and regressive, they attack basic bus services for their low occupancy, high unit costs, and failure to reduce traffic congestion and pollution emissions, and they attack Transit Oriented Development for the long time period it requires to be effective. Clever critics find statistics and examples that support all of these conclusions.

Critics accuse rail transit of being elitist because of its high capital costs and orientation toward more affluent, discretionary travellers. They cite examples in which rail investments displaced investments in basic bus services, reducing services used by transit-dependent users, and where Transit Oriented Development increased local housing prices, which harmed lower-income households. These are certainly concerns to address but it is wrong to assume that high quality transit is inherently regressive and unfair. Transit dependent people can benefit significantly from higher quality (faster, more frequent and more integrated) transit services, and lower income households can benefit significantly if TOD reduces their automobile costs. Rather than comparing rail investments with bus service costs, they should be compared with the full costs of accommodating more automobile travel under the same travel conditions. This suggests that high quality transit and TOD can benefit disadvantaged people provided it is financed with increases in total transit funding, and TODs include a significant amount of lower-priced housing. All of these factors should be considered when evaluating social equity impacts.

Similarly, critics criticize transit for failing to attract discretionary travellers, and therefore failing to reduce traffic congestion and pollution emissions, but this reflects the need to provide basic services in places with low demand. Of course, there are legitimate debates concerning how much of this service to provide, and whether other solutions, such as subsidized taxi services, would be more cost effective and better overall, but it is important to recognize such trade-offs when evaluating system-wide efficiency.

Critics seldom follow the standards required for quality research and analysis: their publications lack comprehensive literature reviews, ignore alternative perspectives or contrary evidence, fail to discuss possible omissions and biases, lack peer review, fail to declare funding sources or conflicts of interests, do not respond to criticisms, and are inadequately referenced. This suggests that critics either do not understand how to perform comprehensive and objective transit impact analysis or they intentionally provide misleading information to support their claims. Regardless, it is important that planning professionals and transit understand these biases and respond with more accurate and comprehensive information.

References

Evan Ackerman (2017), "Toyota's Gill Pratt on Self-Driving Cars and the Reality of Full Autonomy," *Spectrum*, International Institute of Electrical Engineers (www.ieee.org); at https://spectrum.ieee.org/cars-that-think/transportation/self-driving/toyota-gill-pratt-on-the-reality-of-full-autonomy.

Martin W. Adler and Jos N. van Ommeren (2016), "Does Public Transit Reduce Car Travel Externalities? Quasi-Natural Experiments' Evidence From Transit Strikes," *Journal of Urban Economics* (doi:10.1016/j.jue.2016.01.001); at http://papers.tinbergen.nl/15011.pdf.

Md Aftabuzzaman, Graham Currie and Majid Sarvi (2010), "Evaluating the Congestion Relief Impacts of Public Transport in Monetary Terms," *Journal of Public Transportation*, Vol. 13, No. 1, pp. 1-24; at www.nctr.usf.edu/jpt/pdf/JPT13-1.pdf.

Nick Allison, David Lupton and Ian Wallis (2013), *Development of a Public Transport Investment Model*, Research Report 524, NZ Transport Agency (www.nzta.govt.nz); at www.nzta.govt.nz/resources/research/reports/524/docs/524.pdf.

Michael L. Anderson (2013), *Subways, Strikes, and Slowdowns: The Impacts of Public Transit on Traffic Congestion*, Working Paper No. 18757, National Bureau of Economic Research (www.nber.org); at www.nber.org/papers/w18757.

Shlomo Angel and Alejandro M.Blei (2016), "The Productivity of American Cities: How Densification, Relocation, and Greater Mobility Sustain the Productive Advantage of Larger U.S. Metropolitan Labor Markets," *Cities*, Vol. 51, pp. 36-51; at www.sciencedirect.com/science/article/pii/S0264275115300226.

APTA (2007), *A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-Board Surveys*, American Public Transportation Association (www.apta.com); at http://bit.ly/1fQL8OD.

APTA (2016), *Transit Fact Book*, American Public Transportation Association (www.apta.com); at www.apta .com/resources/statistics/Pages/transitstats.aspx.

APTA (2017), *Who Rides Public Transportation?*, American Public Transportation Association (www.apta.com); at http://bit.ly/2mSoqQ0.

G.B. Arrington, et al. (2008), *Effects of TOD on Housing, Parking, and Travel*, Report 128, Transit Cooperative Research Program (www.trb.org/CRP/TCRP/TCRP.asp).

ATAP (2017), *Australian Transport Assessment and Planning Guidelines*, ATAP Steering Committee Secretariat (https://atap.gov.au) Australia Department of Infrastructure and Regional Development; https://atap.gov.au/mode-specific-guidance/public-transport.

Daniel A. Badoe and Eric Miller (2000), "Transportation-Land Use Interaction: Empirical Finding in North America, and Their Implications for Modeling," Transportation Research D, Vol. 5, No. 4, (www.elseier.com/locate/trd), pp. 235-263.

Linda Bailey (2007), "Public Transportation and Petroleum Savings in the U.S.: Reducing Dependence on Oil," American Public Transportation Association (www.apta.com); at http://tinyurl.com/23umk4x.

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

Nathaniel Baum-Snow and Matthew E. Kahn (2005), *The Effects of Urban Rail Transit Expansions: Evidence from Sixteen Cities, 1970 to 2000*, Brookings Papers on Urban Affairs (http://muse.jhu.edu/article/192572).

Eric Beaton (2006), *The Impacts of Commuter Rail in Greater Boston*, Rappaport Institute for Greater Boston, Harvard University (www.ksg.harvard.edu); at http://bit.ly/2xHFp8L.

Antonio M. Bento, et al. (2003), *The Impact of Urban Spatial Structure on Travel Demand in the United States*, World Bank Group Working Paper 2007, World Bank (www-wds.worldbank.org).

Nate Berg (2012), *Boosting Ridership by Replacing Buses with Rail*, Atlantic Cities (www.theatlanticcities.com); at www.theatlanticcities.com/commute/2012/09/boosting-ridership-replacing-buses-rail/3222.

Lawrence Blincoe, et al. (2014), *The Economic And Societal Impact Of Motor Vehicle Crashes, 2010*, Report No. DOT HS 812 013, National Highway Traffic Safety Administration (www-nrd.nhtsa.dot.gov); at www-nrd.nhtsa.dot.gov/Pubs/812013.pdf.

BLS (2007), *2005 Consumer Expenditures*, Bureau of Labor Statistics (www.bls.gov); at www.bls.gov/cex/home.htm.

Marlon G. Boarnet and Doug Houston (2013), *The Exposition Light Rail Line Study: A Before-and-After Study of the Impact of New Light Rail Transit Service*, UCLA Price School of Public Policy (http://priceschool.usc.edu); at http://priceschool.usc.edu/expo-line-study.

Dominique Bouf and David Hensher (2007), *The Dark Side of Making Transit Irresistible: The Example of France*, Working Paper ITLS-WP-07-10, Institute Of Transport And Logistics Studies, University of Sydney (http://itls.econ.usyd.edu.au); at https://halshs.archives-ouvertes.fr/halshs-00266224/document.

Shannon Bouton, et al. (2015), *Urban Mobility at a Tipping Point*, McKinsey & Company (www.mckinsey.com); at www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/urban-mobility-at-a-tipping-point.

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

Edward Carman, Berry Bluestone and Eleanor White (2003), *Building on our Heritage: A Housing Strategy for Smart Growth and Economic Development*, Center for Urban and Regional Policy, Northwestern University (www.curp.neu.edu).

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

CBC (2014), *Housing Affordability Versus Location Affordability*, Citizens Budge Commission (https://cbcny.org); at https://cbcny.org/housing-affordability-versus-location-affordability.

CDC (2015), *Transportation Health Impact Assessment Toolkit*, Center for Disease Control and Prevention (www.cdc.gov/transportation/default.htm).

Robert Cervero, et al (2004), *Transit-Oriented Development in the United States: Experience, Challenges, and Prospects*, TCRP, TRB (http://gulliver.trb.org/publications/tcrp/tcrp_rpt_102.pdf).

Robert Cervero (2007), "Transit Oriented Development's Ridership Bonus: A Product of Self Selection and Public Policies," *Environment and Planning*, Vol. A, No. 39, pp. 2068-2085; at www.uctc.net/papers/765.pdf.

CFTE (2003), *CFTE O'Toole Response*, Center for Transportation Excellence (www.cfte.org); at www.cfte.org/critics/O'Toole%20response.pdf.

CFTE (2005), *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).

Mikhail Chester and Arpad Horvath (2008), *Environmental Life-cycle Assessment of Passenger Transportation: A Detailed Methodology for Energy, Greenhouse Gas and Criteria Pollutant Inventories of Automobiles, Buses, Light Rail, Heavy Rail and Air v.2*, UC Berkeley Center for Future Urban Transport, (www.its.berkeley.edu/volvocenter/), Paper vwp-2008-2; at www.sustainable-transportation.com and http://escholarship.org/uc/item/7n29n303#page-36.

Mikhail Chester, Arpad Horvath and Samer Madanat (2010), "Parking Infrastructure: Energy, Emissions, And Automobile Life-Cycle Environmental Accounting," *Environmental Research Letters*, Vol. 5, No. 3; at http://dx.doi.org/10.1088/1748-9326/5/3/034001;

Harry Chmelynski (2008), *National Economic Impacts per $1 Million Household Expenditures (2006); Spreadsheet Based On IMPLAN Input-Output Model*, Jack Faucett Associates (www.jfaucett.com).

Giovanni Circella, et al. (2017), *What Affects Millennials' Mobility? PART II: The Impact of Residential Location, Individual Preferences and Lifestyle on Young Adults' Travel Behavior in California*, National Center for Sustainable Transportation (https://ncst.ucdavis.edu); at www.trb.org/main/blurbs/176078.aspx.

CNT (2010), *Penny Wise, Pound Fuelish: New Measures of Housing + Transportation Affordability*, Center for Neighborhood Technology (www.cnt.org); at www.cnt.org/repository/pwpf.pdf.

CNT (2013), *The New Real Estate Mantra: Location Near Public Transportation*, Center for Neighborhood Technology (www.cnt.org), American Public Transportation Association (www.apta.com), National Association of Realtors (www.realtor.org); at www.cnt.org/repository/The_New_Real_Estate_Mantra.pdf.

CNT (2017), *Housing and Transportation (H+T) Affordability Index*, Center for Neighborhood Technology (www.cnt.org); at https://htaindex.cnt.org.

Joe Cortright (2010), *Driven Apart: How Sprawl is Lengthening Our Commutes and Why Misleading Mobility Measures are Making Things Worse*, CEOs for Cities (www.ceosforcities.org); at www.ceosforcities.org/work/driven-apart.

Joe Cortright (2015), *Surging City Center Job Growth*, CEOs for Cities (www.ceosforcities.org); at http://cityobservatory.org/city-center-jobs.

Wendell Cox (2000), *Urban Rail: Uses and Misuses*, The Public Purpose (www.publicpurpose.com).

Wendell Cox (2003), *Performance Indicators in Urban Transport Planning*, Presented to the 8th International Conference on Competition and Ownership in Land Passenger Transport ("Thredbo 8") Rio de Janeiro; at www.publicpurpose.com/t8-gbc.pdf.

Wendell Cox (2004) *Why Not Just Buy Them Cars*, The Hartland Foundation (www.heartland.org/Article.cfm?artId=15340).

Wendell Cox (2010), *Washington's War on Cars and the Suburbs: Secretary LaHoods False Claims on Roads and Transit*, Reason Foundation (www.heritage.org); at www.heritage.org/Research/Reports/2010/06/Washingtons-War-on-Cars-and-the-Suburbs-Secretary-LaHoods-False-Claims-on-Roads-and-Transit.

Wendell Cox (2014), *Evaluating Urban Rail*, New Geography (www.newgeography.com); at www.newgeography.com/content/004789-evaluating-urban-rail.

Wendell Cox and Randal O'Toole (2004), *The Contribution of Highways and Transit to Congestion Relief: A Realistic View*, Heritage Foundation (www.heritage.org); at www.heritage.org/Research/Reports/2004/01/The-Contribution-of-Highways-and-Transit-to-Congestion-Relief-A-Realistic-View.

Wendell Cox and Joel Kotkin (2017), *The Great Train Robbery: Urban Transportation in the 21st Century*, Chapman University (www.chapman.edu); at www.chapman.edu/wilkinson/_files/cdp-transit-web-sm.pdf.

Wendell Cox and Ronald D. Utt (2010), *Toward Creating Sustainable Transit*; Heritage Foundation (www.heritage.org); at www.heritage.org/Research/Reports/2010/06/Toward-Creating-Sustainable-Transit.

CTOD (2009a), *Destinations Matter: Building Transit Success*, Center for Transit Oriented Development, Reconnecting America (www.reconnectingamerica.org); at www.reconnectingamerica.org/public/display_asset/ctodwp_destinations_matter.

CTOD (2009b), *Mixed-Income Housing TOD Action Guide*, Center for Transit Oriented Development (CTOD) for Reconnecting America, the Center for Neighborhood Technology (www.reconnectingamerica.org); at http://reconnectingamerica.org/public/display_asset/090304mitodag0109.

CTOD and CNT (2006), *The Affordability Index: A New Tool for Measuring the True Affordability of a Housing Choice*, Center for Transit-Oriented Development and the Center for Neighborhood Technology, Brookings Institute (www.brookings.edu); at www.brookings.edu/metro/umi/20060127_affindex.pdf.

CTS (2009), *Understanding the Impacts of Transitways: Demographic and Behavioral Differences between Hiawatha Light-Rail and Other Transit Riders*, Center for Transportation Studies, University of Minnesota (www.cts.umn.edu/Research/Featured/Transitways); at www.cts.umn.edu/Publications/ResearchReports/pdfdownload.pl?id=1332.

CTS (2010), *How Light-Rail Transit Improves Job Access for Low-Wage Workers: A Transitway Impacts Research Program (TIRP) Research Brief*, Center for Transportation Studies, University of Minnesota (www.cts.umn.edu); at www.cts.umn.edu/Research/Featured/Transitways/documents/lowincome.pdf.

CTS (2013), *Research Synthesis: Transforming Community: Research Indicates Transitways are Improving Mobility, Spurring Economic Growth and Development, and Supporting Equity*, Center for Transportation Studies, University of Minnesota (www.cts.umn.edu/Research/Featured/Transitways); at www.cts.umn.edu/research/featured/transitways/synthesis.

Amélie Y. Davis, et al. (2010), "Estimating Parking Lot Footprints In The Upper Great Lakes Region Of The USA" *Landscape and Urban Planning*, Vol. 96, Issue 2, 30 May 2010, Pages 68-77; at www.citeulike.org/article/6869205.

Patrick Decorla-Souza and Ronald Jensen-Fisher (1997), "Comparing Multimodal Alternatives in Major Travel Corridors," *Transportation Research Record 1429* (www.trb.org), pp. 15-23,

Leroy W. Demery, Jr. Michael D. Setty (2005), *Flyvbjerg, Skamris Holm and Buhl: Deja vu All Over Again?*, Publictransit.us Special Report No. 5 (www.publictransit.us); at www.publictransit.us/ptlibrary/specialreports/sr5.Flyvbjerg_Deja_Vue.htm.

Tyler Durden (2016), *Top 25 Corporate Pension Plans Alone Are Underfunded By Over $225 Billion*, Zero Hedge (www.zerohedge.com); at www.zerohedge.com/news/2016-08-22/top-25-underfunded-corporate-pension-plans-are-225bn-underwater.

ECONorthwest and PBQD (2002), *Estimating the Benefits and Costs of Public Transit Projects*, TCRP Report 78, TRB (www.trb.org); at www.trb.org/Publications/Blurbs/153766.aspx.

Alan Ehrenhalt (2009), "Paul Weyrich's Soft Spot for Public Transit: The Late Conservative Leader Debunks The Free-Market Case Against Transit," *Governing Magazine* (www.governing.com); at www.governing.com/column/paul-weyrichs-soft-spot-public-transit.

Alan Ehrenhalt (2016), "Urbanophobia: A Growing Threat to Public Transit in America: In the Ideological War over Urban Planning, Anti-transit Conservatives are Gaining Funding and Allies," *Governing Magazine* (www.governing.com); www.governing.com/columns/assessments/gov-agenda-21-koch-transit.html.

John E. Evans and Richard H. Pratt (2007), *Transit Oriented Development; Chapter 17, Travel Response To Transportation System Changes*, TCRP Report 95, Transportation Research Board (www.trb.org); at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034.

Reid Ewing, Rolf Pendall and Don Chen (2002), *Measuring Sprawl and Its Impacts*, Smart Growth America (www.smartgrowthamerica.org); at www.smartgrowthamerica.org/sprawlindex/MeasuringSprawl.PDF.

Reid Ewing and Shima Hamidi (2014), *Measuring Urban Sprawl and Validating Sprawl Measures*, Metropolitan Research Center at the University of Utah for the National Cancer Institute, the Brookings Institution and Smart Growth America (www.smartgrowthamerica.org); at www.arch.utah.edu/cgi-bin/wordpress-metroresearch.

Reid Ewing, Guang Tian and Allison Spain (2014), *Effect of Light-Rail Transit on Traffic in a Travel Corridor*, National Institute for Transportation and Communities (www.otrec.us); at http://nitc.trec.pdx.edu/research/project/611.

Christopher E. Ferrell (2015), *The Benefits of Transit in the United States: A Review and Analysis of Benefit-Cost Studies*, Mineta Transportation Institute (http://transweb.sjsu.edu); at http://transweb.sjsu.edu/PDFs/research/1425-US-transit-benefit-cost-analysis-study.pdf.

FHWA (various years), *Highway Statistics*, Federal Highway Administration (www.fhwa.dot.gov); at www.fhwa.dot.gov/policyinformation/statistics.cfm.

Bent Flyvbjerg, Mette Skamris Holm and Søren Buhl (2002), "Underestimating Costs In Public Works Projects: Error or Lie?," *Journal of the American Planning Association*, Vol. 68, No. 3, pp. 279-295; at http://flyvbjerg.plan.aau.dk/JAPAASPUBLISHED.pdf.

Yonah Freemark (2014a), *Recent Trends in Bus and Rail Ridership*, The Transport Politic (www.thetransportpolitic.com); at www.thetransportpolitic.com/2014/03/03/recent-trends-in-bus-and-rail-ridership.

Yonah Freemark (2014b), *Calgary's Soaring Transit Use Suggests High Ridership Is Possible Even In Sprawling Cities*, The Transport Politic (www.thetransportpolitic.com); at www.thetransportpolitic.com/2014/12/10/calgarys-soaring-transit-use-suggests-high-ridership-is-possible-even-in-sprawling-cities.

Chad Frederick, William Riggs and John Hans Gilderbloom (2017), "Commute Mode Diversity and Public Health: A Multivariate Analysis of 148 US Cities," *International Journal of Sustainable Transportation* (http://dx.doi.org/10.1080/15568318.2017.1321705).

FTA (2002), *Transit Performance Monitoring System (TPMS) Results*, American Public Transit Association (www.apta.com) and the Federal Transit Administration (www.fta.dot.gov); at www.apta.com/government_affairs/tpms/index.cfm.

FTA (2007), *Contractor Performance Assessment Report*, Federal Transit Administration (www.fta.dot.gov); at www.fta.dot.gov/documents/CPAR_Final_Report_-_2007.pdf.

Frank Gallivan, et al. (2015), *Quantifying Transit's Impact on GHG Emissions and Energy Use—The Land Use Component*, Report 176, Transit Cooperative Research Program (www.tcrponline.org); at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_176.pdf.

Thomas A. Garrett (2004), *Light-Rail Transit in America Policy Issues and Prospects for Economic Development*, Federal Reserve Bank of St. Louis (www.stlouisfed.org); at www.stlouisfed.org/community_development/assets/pdf/light_rail.pdf.

GAO (2004), *Highways and Transit: Private Sector Sponsorship Of And Investment In Major Projects Has Been Limited*, General Accounting Office, GAO-04-419 (www.gao.gov).

Haynes Goddard (2009), *A Review of "On the Social Desirability of Urban Rail Systems" by C. Winston and V. Maheshrib*, Department of Economics, University of Cincinnati; at www.vtpi.org/goddard.pdf.

Roger Gorham (2009), *Demystifying Induced Travel Demand*, Sustainable Transportation Technical Document, Sustainable Urban Transportation Project (www.sutp.org) and GTZ (www.gtz.de); at http://bit.ly/2eIWBnz.

Bern Grush (2016), *Driverless Cars Ahead: Ontario Must Prepare for Vehicle Automation*, Residential and Civil Construction Alliance of Ontario (RCCAO); at http://rccao.com/research/files/RCCAO_Vehicle-Automation_OCT2016_WEB.pdf.

Evan Gwee, Graham Currie and John Stanley (2011), *Exploring International Variation in Approaches to Urban Rail Project Evaluation - Impact on Project Outcomes*, Transportation Research Board Annual Meeting (www.trb.org); at http://trb.metapress.com/content/k00381553h0353p7.

Susan Handy, Steve Spears and Marlon G. Boarnet (2013), *Draft Policy Brief on the Impacts of Transit Service Strategies Based on a Review of the Empirical Literature*, for Research on Impacts of Transportation and Land Use-Related Policies, California Air Resources Board (http://arb.ca.gov/cc/sb375/policies/policies.htm).

Carmen Hass-Klau, Graham Crampton and Rabia Benjari (2004), *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).

Lyndon Henry and David D. Dobbs (2005), *Why St. Louis's MetroLink Light Railway Is a Mobility Bargain: A Response to Recent Anti-Rail Transit Diatribes Published by the Federal Reserve Bank of St. Louis*, Light Rail Now (www.lightrailnow.org); at www.lightrailnow.org/myths/m_stl_2005-01.htm.

Lyndon Henry and Dave Dobbs (2013), *Comparative Examination of New Start Light Rail Transit, Light Railway, and Bus Rapid Transit Services Opened from 2000*, 12th National Light Rail Conference, Transportation Circular E-C177, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/circulars/ec177.pdf.

Lyndon Henry and Todd Litman (2006), *Evaluating New Start Transit Program Performance Comparing Rail and Bus*, presented at the Joint International Light Rail Conference; at www.vtpi.org/bus_rail.pdf.

Joel S. Hirschhorn (2001), *New Community Design to the Rescue*, NGA (www.nga.org).

HLB (2002), *Economic Study to Establish a Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments*, Transport Canada (www.tc.gc.ca); at www.bv.transports.gouv.qc.ca/mono/1060268.pdf.

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

Chang-Tai Hsieh and Enrico Moretti (2017), *Housing Constraints and Spatial Misallocation*, University of California, Berkeley and the National Bureau of Economic Research (www.nber.org); at http://eml.berkeley.edu/~moretti/growth.pdf.

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

ICF (2010), *Current Practices in Greenhouse Gas Emissions Savings from Transit: A Synthesis of Transit Practice*, TCRP 84, TRB (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_84.pdf.

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

Wenya Jia and Martin Wachs (1998), *Parking Requirements and Housing Affordability; A Case Study of San Francisco*, Research Paper 380, UTCD (www.uctc.net).

Tom Keane (2006), "Commuter Rail's False Promise: Why More Rail Lines Won't Prod More Folks To Take The Train - And Why We Should Make Peace With Cars," *Boston Globe*, 31 Dec.; at www.boston.com/news/globe/magazine/articles/2006/12/31/commuter_rails_false_promise.

Jeff Kenworthy (2008), "An International Review of The Significance of Rail in Developing More Sustainable Urban Transport Systems in Higher Income Cities," *World Transport Policy & Practice*, Vol. 14, No. 2 (www.eco-logica.co.uk); at www.eco-logica.co.uk/pdf/wtpp14.2.pdf.

Mindy Kimball, Mikhail Chester, Christopher Gino, and Janet Reyna (2013), "Assessing the Potential for Reducing Life-Cycle Environmental Impacts through Transit-Oriented Development Infill along Existing Light Rail in Phoenix," *Journal of Planning Education & Research* (http://jper.sagepub.com), December, Vol. 33, No. 4, pp. 395-410; at http://jpe.sagepub.com/content/33/4/395.full.

Irem Kok, et al. (2017), *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries*, RethinkX (www.rethinkx.com); at http://bit.ly/2pL0cZV.

Ugo Lachapelle, et al. (2011), "Commuting by Public Transit and Physical Activity: Where You Live, Where You Work, and How You Get There," *Journal of Physical Activity and Health* (http://journals.humankinetics.com/jpah), Vol. 8, Supplement 1, pp. S72-S82; at https://pdfs.semanticscholar.org/1b17/6de4d44bfc1ef12121f890a01ea8a43e3573.pdf.

Bradley W. Lane (2008), "Significant Characteristics of the Urban Rail Renaissance in the United States: A Discriminant Analysis," *Transportation Research A*, Vol. 42, Issue 2 (www.elsevier.com/locate/tra), pp. 279-295.

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

Michael Lewyn (2007), *Debunking Cato: Why Planning in Portland Works Better Than the Analysis of Its Chief Neo-Libertarian Critic*, Congress for New Urbanism (www.cnu.org); at http://cnu.org/sites/files/DebunkingCato.pdf.

Michael Lewyn (2015), *Light Rail Doesn't Always Mean Fewer Buses; Cities that have recently adopted light rail sometimes actually add bus riders*, Planetizen (www.planetizen.com); at www.planetizen.com/node/77810/light-rail-doesnt-always-mean-fewer-buses.

William S. Lind (2010), "Rail Against The Machine: What's So Conservative About Federal Highways," *The American Conservative* (www.amconmag.com), August 2010; at http://t4america.org/wp-content/uploads/2010/07/American-Conservative-August-2010.pdf.

Barbara Lipman (2005), "Something's Gotta Give: Working Families and the Cost of Housing," *New Century Housing*, Volume 5, Issue 2, Center for Housing Policy; at www.nhc.org/pdf/pub_nc_sgg_04_05.pdf.

Todd Litman (2005), "Impacts of Rail Transit on the Performance of a Transportation System," *Transportation Research Record 1930*, Transportation Research Board (www.trb.org), pp. 23-29; summary at http://dx.doi.org/10.3141/1930-03. For more comprehensive analysis see, *Rail Transit In America: Comprehensive Evaluation of Benefits*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/railben.pdf.

Todd Litman (2007), "Evaluating Rail Transit Benefits: A Comment," *Transport Policy*, Vol. 14, No. 1 (www.elsevier.com/locate/tranpol), January, pp. 94-97.

Todd Litman (2009), *Transportation Cost and Benefit Analysis*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tca.

Todd Litman (2010), *Raise My Taxes, Please! Evaluating Household Savings from High Quality Public Transit Service*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/raisetaxes.pdf.

Todd Litman (2010), *Contrasting Visions of Urban Transport: Critique of "Fixing Transit: The Case For Privatization"*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/cont_vis.pdf.

Todd Litman (2011), *The First Casualty of a Non-Existent War: Evaluating Claims of Unjustified Restrictions on Automobile Use, and a Critique of 'Washingtons War On Cars And The Suburbs'*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/carwars.pdf.

Todd Litman (2014), *Critique of "Transit Utilization and Traffic Congestion: Is There a Connection?"* Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/R&M_critique.pdf.

Todd Litman (2015), *Eleven Reasons to Support Vancouver's Transportation Tax*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/VanTransitTax.pdf.

Todd Litman (2015), *Towards More Comprehensive and Multi-Modal Transport Evaluation*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/comp_evaluation.pdf.

Todd Litman (2016), *Smart Congestion Relief: Comprehensive Analysis of Traffic Congestion Costs and Congestion Reduction Benefits,* Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/cong_relief.pdf. Also see Todd Litman (2014), *Congestion Evaluation Best Practices*, International Transportation Economic Development Conference, Dallas, Texas; at www.vtpi.org/ITED_congestion.pdf.

Todd Litman (2016b), *The Hidden Traffic Safety Solution: Public Transportation*, American Public Transportation Association (www.apta.com); at www.apta.com/mediacenter/pressreleases/2016/Pages/Hidden-Traffic-Safety-Solution.aspx.

Todd Litman (2017), *Evaluating Public Transportation Benefits and Costs*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tranben.pdf.

Todd Litman (2017), *Public Transportation's Impact on Rural and Small Towns: A Vital Mobility Link*, American Public Transportation Association (www.apta.com); at www.apta.com/rural.

Shih-Che Lo and Randolph W. Hall (2006), "Effects of the Los Angeles Transit Strike on Highway Congestion," *Transportation Research A*, Vol. 40, No. 10 (www.elsevier.com/locate/tra), December, pp. 903-917.

LRN (2001), *Most Light Rail Projects Within Budget, On Time* (www.lightrailnow.org/myths/m_lrt009.htm) and *Light Rail's Stunning Track Record in Meeting – and Exceeding – Ridership Projections*, Light Rail Now! (www.lightrailnow.org).

LRN (2005), *Randal O'Toole's 'Great Rail Disaster': Ideological Train Wreck Disguised as 'Research Study'*, Light Rail Now (www.lightrailnow.org/features/f_lrt_2005-04.htm).

LRN (2006), *Rail Transit vs. "Bus Rapid Transit": Comparative Success and Potential in Attracting Ridership*, Light Rail Now (www.lightrailnow.org/facts/fa_brt_2006-08a.htm).

Hollie M. Lund, Robert Cervero and Richard W. Willson (2004), *Travel Characteristics of Transit-Oriented Development in California*, Caltrans Statewide Planning Studies; at www.csupomona.edu/~rwwillson/tod/Pictures/TOD2.pdf.

Glenn Lyons, Juliet Jain and David Holley (2007), "The Use of Travel Time by Rail Passengers in Great Britain," *Transportation Research A*, Vol. 41, No. 1, Jan. 2007, pp. 107-120.

Barbara McCann (2000), *Driven to Spend; The Impact of Sprawl on Household Transportation Expenses*, STPP (www.transact.org).

Robert H. Muller (2001), *Tollroad Feasibility Studies; An Historical Perspective*, Transportation Research Board Annual Meeting, (www.nas.edu/trb).

Dowell Myers and SungHo Ryu (2008), "Aging Baby Boomers and the Generational Housing Bubble: Foresight and Mitigation of an Epic Transition," *Journal of the American Planning Association*, Vol. 74, No. 1, pp. 17- 33; at http://pdfserve.informaworld.com/631649__789053981.pdf.

NACTO (2018), *Making Transit Count: Performance Measures that Move Transit Projects Forward*, National Association of City Transportation Officials (https://nacto.org); at https://nacto.org/wp-content/uploads/2018/04/NACTO-Making-Transit-Count.pdf.

M.I. Nadiri and T.P. Mamuneas (1996), *Contribution of Highway Capital to Industry and National Productivity Growth*, FHWA, USDOT. Also see, Theofanis Mamuneas and Ishaq Nadiri (2006), *Production, Consumption and Rates of Return to Highway Infrastructure Capital*, National Bureau of Economic Research (www.nber.org); at http://tinyurl.com/ksv8w4.

NAR (2015), *Community Preference Surveys*, National Association of Realtors (www.nar.realtor); at www.nar.realtor/reports/nar-2015-community-preference-survey.

National Searchable TOD Database (www.cnt.org/tools/tod-database).

Arthur C. Nelson, Rolf Pendall, Casy Dawkins and Gerrit Knaap (2002), *The Link Between Growth Management and Housing Affordability: The Academic Evidence*, Brookings Institute (www.brookings.edu/es/urban/publications/growthmanagexsum.htm).

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

Peter Newman, Jeffrey Kenworthy and Gary Glazebrook (2013), "Peak Car Use and the Rise of Global Rail: Why This Is Happening and What It Means for Large and Small Cities," *Journal of Transportation Technologies*, Vol.3 No.4 (DOI:10.4236/jtts.2013.34029); at http://file.scirp.org/Html/6-3500146_38472.htm.

Lee Nichols (2011), "Why Rail? The City Is Pushing For A 2012 Vote To Build Urban Rail; The Critics Are Asking, 'Who Needs It?'" *Austin Chronicle* (www.austinchronicle.com); at www.austinchronicle.com/news/2011-04-08/why-rail.

NRDC (2010), *Reducing Foreclosures and Environmental Impacts through Location-Efficient Neighborhood Design*, Natural Resources Defense Council (www.nrdc.org); at www.nrdc.org/energy/files/LocationEfficiency4pgr.pdf.

NZTA (2017), *Economic Evaluation Manual*, Volumes 1 and 2, New Zealand Transport Agency (www.nzta.govt.nz); at www.nzta.govt.nz/resources/economic-evaluation-manual/volume-1/index.html and www.nzta.govt.nz/resources/economic-evaluation-manual/volume-2/docs/eem2-july-2010.pdf.

Randal O'Toole (2004), *Great Rail Disasters; The Impact Of Rail Transit On Urban Livability*, Reason Public Policy Institute (www.rppi.org), also at (www.texaspolicy.com).

Randal O'Toole (2005), *Rail Disasters 2005: The Impact Of Rail Transit On Transit Ridership*, American Dream Coalition (www.americandreamcoalition.org).

Randal O'Toole (2006), *A Desire Named Streetcar: How Federal Subsidies Encourage Wasteful Local Transit Systems*, Cato Institute (www.cato.org/pubs/pas/pa559.pdf).

Randal O'Toole (2009), *Getting What You Paid For -- Paying For What You Get: Proposals for the Next Transportation Reauthorization*, Policy Analysis no. 644, Cato Institute (www.cato.org); at www.cato.org/pub_display.php?pub_id=10538.

Randal O'Toole (2010), *Defining Success: The Case against Rail Transit*, Cato Institute (www.cato.org); at www.cato.org/pub_display.php?pub_id=11608.

Randal O'Toole (2010), *Colorado Transit: A Costly Failure*, Center for the American Dream (http://i2i.org); at http://transportation.i2i.org/files/2010/07/IB-2010-C.pdf.

Andrew Owen and David Levinson (2014), *Access Across America: Transit 2014*, Center for Transportation Studies (www.its.umn.edu); at www.its.umn.edu/Publications/ResearchReports/pdfdownloadl.pl?id=2506.

Randal O'Toole (2017), *The Coming Transit Apocalypse*, Cato Institute (www.cato.org); at www.cato.org/publications/policy-analysis/coming-transit-apocalypse.

Ian W.H. Parry and Kenneth A. Small (2007), *Should Urban Transit Subsidies Be Reduced?* Discussion Paper 07-38, Resources for the Future (www.rff.org); at www.rff.org/rff/documents/rff-dp-07-38.pdf.

Parsons Brinckerhoff (2013), *Improving our Understanding of How Highway Congestion and Price Affect Travel Demand*, Report S2-C04-RW-1, Strategic Highway Research Program, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-C04-RW-1.pdf.

Don Pickrell (1992), "A Desire Named Streetcar: Fantasy and Fact in Rail Transit Planning," *Journal of the American Planning Association*, Vol. 58, No. 2, Spring, pp. 158-76; at www.csus.edu/indiv/c/chalmersk/ECON251FA12/ADesireNamedStreetcar.pdf.

Alan Pisarski (2006), *Commuting In America III*, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/nchrp/ciaiii.pdf.

Bruce Podobnik (2002), *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).

Stephanie Pollack, Anna Gartsman and Jeff Wood (2013), *eTOD Station Area Rating System*, Dukakis Center for Urban and Regional Policy (www.dukakiscenter.org); at www.northeastern.edu/dukakiscenter/wp-content/uploads/2013/10/ES-final-10-17-13.pdf.

John Poorman (2005), "A Holistic Transportation Planning Framework For Management And Operations," *ITE Journal*, Vol. 75, No. 5 (www.ite.org), May, pp. 28-32; at www.ite.org/membersonly/itejournal/pdf/2005/JB05EA28.pdf.

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

PSRC (2008), *Traffic Choices Study: Summary Report*, Puget Sound Regional Council (http://psrc.org); at http://psrc.org/assets/37/summaryreport.pdf.

Boris S. Pushkarev and Jeffrey M. Zupan (1997), *Public Transportation & Land Use Policy*, A Regional Planning Association Book, Indiana University Press (www.indiana.edu/~iupress).

Steven Raphael and Michael Stoll (2000), *Can Boosting Minority Car-ownership Rates Narrow Inter-Racial Employment Gaps?* Working Paper W00-002, Program on Housing and Urban Policy, University of California at Berkeley (http://urbanpolicy.berkeley.edu).

RCLCO (2008), *Measuring the Market for Green Residential Development*, Robert Charles Lesser and Company (www.rclco.com); at www.rclco.com/pdf/Measuring_the_Market.pdf.

Reconnecting America (2004), *Hidden in Plain Sight: Capturing the Demand for Housing Near Transit*, Center for Transit-Oriented Development; Reconnecting America (www.reconnectingamerica.org) for the Federal Transit Administration; at www.reconnectingamerica.org/public/show/hipsi.

John L. Renne (2005), *Transit-Oriented Development: Measuring Benefits, Analyzing Trends, And Evaluating Policy*, Dissertation, Rutgers State University; at https://trid.trb.org/view.aspx?id=854786.

Ricardo-AEA (2014), *Update of the Handbook on External Costs of Transport Final Report*, European Commission (http://ec.europa.eu); at https://bit.ly/2c4e0b1.

RPA (2017), *New Mobility Autonomous Vehicles and the Region*, Regional Planning Association (www.rpa.org); at https://bit.ly/2r6DE3I.

Thomas A. Rubin and Fatma Mansour (2013), *Transit Utilization and Traffic Congestion: Is There a Connection?*, Reason Foundation (www.reason.org); at https://bit.ly/2E1jAbQ.

Shared Mobility Principles (www.sharedmobilityprinciples.org).

Bruce Schaller (2017), *Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City*, Schaller Consulting (http://schallerconsult.com); at http://schallerconsult.com/rideservices/unsustainable.htm.

Angie Schmitt (2016), *Uber Can't Replace Transit — Here Are 3 Reasons Why*, Streetblog (www.usa.streetsblog.org); at https://bit.ly/2SfVuNn.

John Schumann (2005), "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*, TRB (www.trb.org) pp. 62-67.

Donald C. Shoup (1999), "In Lieu of Required Parking," *Journal of Planning Education and Research*, Vol. 18, 1999, pp. 307-320; at https://bit.ly/2DNJCy6.

Donald Shoup (2005), *The High Cost of Free Parking*, Planners Press (www.planning.org).

Donald Shoup (2011), "Free Parking or Free Markets," *CATO Unbound* (www.cato-unbound.org); at www.cato-unbound.org/2011/04/04/donald-shoup/free-parking-or-free-markets.

Tom Simonite (2016), "Prepare to be Underwhelmed by 2021's Autonomous Cars: Ford, Uber, and BMW Promise Fully Self-Driving Cars in Five Years—But They Will Probably Only Work in Very Limited Areas," *MIT Technology Review* (www.technologyreview.com); at https://bit.ly/2PZxH6X.

Michael J. Smart and Nicholas J. Klein (2015), *A Longitudinal Analysis of Cars, Transit, and Employment Outcomes*, Mineta National Transit Research Consortium (http://transweb.sjsu.edu); at https://bit.ly/1k4Nr58.

Jeffery J. Smith and Thomas A. Gihring (2004), *Financing Transit Systems Through Value Capture: An Annotated Bibliography*, VTPI (www.vtpi.org); at www.vtpi.org/smith.pdf.

Source Watch (www.sourcewatch.org).

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

STPP (2001), *Easing the Burden: A Companion Analysis of the Texas Transportation Institute's Congestion Study*, Surface Transportation Policy Project (www.transact.org).

Subsidy Scope (2009), *Analysis Finds Shifting Trends in Highway Funding: User Fees Make Up Decreasing Share*, Subsidy Scope (www.subsidyscope.com); at https://bit.ly/2TPCkQ6.

Kerri Sullivan (2003), *Transportation & Work: Exploring Car Usage and Employment Outcomes in the LSAL Data*, National Center for the Study of Adult Learning and Literacy (www.ncsall.net); at www.ncsall.net/fileadmin/resources/research/op_sullivan.pdf.

TCRP (2012), *Assessing and Comparing Environmental Performance of Major Transit Investments*, Transit Cooperative Research Program (www.tcrponline.org); at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w55.pdf.

Gregory Thompson, et al. (2012), *Understanding Transit Ridership Demand For A Multi-Destination, Multimodal Transit Network in an American Metropolitan Area*, Report 11-06, Mineta Transportation Institute (www.transweb.sjsu.edu); at http://bit.ly/2vNKwmv.

TranSystems Corporation (2005), *Elements Needed to Create High Ridership Transit Systems*, Transportation Research Board (www.trb.org), Web Document 32; at https://bit.ly/2ztMRYF.

TRB (2017), *Strategies to Advance Automated and Connected Vehicles*, Transportation Research Board (www.trb.org); at www.nap.edu/download/24873.

TriMet (2007), *TriMet Review of "Debunking Portland: The Public Transit Myth"*, TriMet (www.trimet.org); at http://trimet.org/pdfs/publications/review_debunking_portland.pdf.

Richard Truett (2016), "Don't Worry: Autonomous Cars Aren't Coming Tomorrow (or Next Year). True autopilot Software Still Needs a Decade of Work," *AutoWeek*; at https://bit.ly/2ArEgW0.

UITP (2009), *Assessing the Benefits of Public Transport*, Position Paper, International Association of Public Transport (www.uitp.org); at www.uitp.org/mos/focus/FPBenefits-en.pdf.

UITP (2013), *Ticket to the Future: 3 Stops to Sustainable Mobility*, UITP (www.uitp.org); at http://bit.ly/2gmKXys.

George M. Vredeveld, Jeff Rexhausen and G. Irem Yelkanci (2008), *An Assessment of the Cincinnati Street Car Study*, Economics Center for Education & Research, University of Cincinnati (www.uc.edu/cfc); at www.cincinnati-oh.gov/city/downloads/city_pdf34212.pdf.

Jarrett Walker (2015), *Why is US Bus Service Shrinking as Demand is Rising?*, Human Transit (http://humantransit.org); at https://bit.ly/2mHUfZ5.

Jarrett Walker (2016), *How to Read the Best Anti-Transit Writing*, Human Transit (http://humantransit.org); at https://bit.ly/1SSdRWa.

Ian Wallis, A. Lawrence and Neil Douglas (2013), *Economic Appraisal of Public Transport Service Enhancements*, Report 533, New Zealand Transport Agency (www.nzta.govt.nz); at www.nzta.govt.nz/resources/research/reports/533/docs/533.pdf.

Glen Weisbrod, et al. (2017), *Practices for Evaluating the Economic Impacts and Benefits of Transit*, TCRP Synthesis 128, Transportation Research Board (www.trb.org); at www.trb.org/main/blurbs/175968.aspx.

Jay Warner (2007), *Reassessing 'The Social Desirability of Urban Rail Transit Systems': Critique of Winston and Maheshri*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/warner.pdf.

Richard Wener, Gary W. Evans and Jerome Lutin (2006), *Leave the Driving to Them: Comparing Stress pf Car and Train Commuters*, American Public Transportation Association (www.apta.com); at https://trid.trb.org/view.aspx?id=789677.

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

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

Clifford Winston and Vikram Maheshri (2006), *On The Social Desirability Of Urban Rail Transit Systems*, Journal of Urban Economics; at https://bit.ly/2FHVCnx.

WNYC (2017), *Average Commute Times*, WNYC (https://wnyc.org); at https://bit.ly/2QiQDxJ.

Lloyd Wright (2007), *Bus Rapid Transit Planning Guide*, Institute for Transportation and Development Policy (www.itdp.org); at www.itdp.org/index.php/microsite/brt_planning_guide.

WSDOT (2004), *Highway Construction Costs: Are WSDOT's Highway Construction Costs in Line with National Experience?*, Washington State Department of Transportation (www.wsdot.wa.gov); at www.vtpi.org/WSDOT_HighwayCosts_2004.pdf.

Lunyu Xie (2012), *Automobile Usage and Urban Rail Transit Expansion*, Environment for Development and Resources for the Future (www.rff.org); at https://bit.ly/2Sdl8lV.

Chang Yi (2006), "The Impact of Public Transit on Employment Status: Disaggregate Analysis of Houston," *Transportation Research Record 1986*, TRB (www.trb.org), pp. 137-144; at http://dx.doi.org/10.3141/1986-19.

Kevin Jingyi Zhang (2012), *Bus Stop Urban Design: Nine Techniques for Enhancing Bus Stops and Neighbourhoods and their Application in Metro Vancouver*, The University of British Columbia and Pacific Institute for Climate Solutions (www.pics.uvic.ca); at https://bit.ly/2E0UvO8.