www.vtpi.org

Info@vtpi.org

Phone & Fax: 250-360-1560

Critique of
"*Transit Utilization and Traffic Congestion: Is There a Connection?*"

24 April 2014

By
Todd Litman
Victoria Transport Policy Institute

High quality (relatively convenient, fast and comfortable) transit service tends to reduce congestion. Buses in mixed traffic do not. Targeted analysis is required to accurately measure these impacts.

Summary
The study, *Transit Utilization and Traffic Congestion: Is There a Connection?* by Thomas A. Rubin and Fatma Mansour, found a positive correlation between public transit utilization (per capita transit trips and passenger-miles) and traffic congestion intensity (increased Travel Time Index) among U.S. cities. They claim this demonstrates that public transit is ineffective at reducing congestion. This report critiques their study. Their analysis contains omissions and biases which tend to underestimate the congestion reductions provided by high quality transit: it uses congestion intensity rather than congestion costs indicators, and so it ignores the congestion avoided by users of grade-separated transit; it fails to account for confounding factors such as city size, density and employment rates; it includes all regional transit use although only high quality, grade separated service on major urban corridors is expected to reduce congestion. Other studies which account for these factors indicate that high quality transit can reduce congestion. As a result of their omissions and biases, Rubin and Mansour's study provides no guidance for answering policy questions such as whether appropriate transit service improvements can help reduce congestion, and how to maximize the value of transit investments.

Introduction

Traffic congestion is a significant transportation problem and congestion reduction an important planning objective. There is often debate concerning which solutions are best overall. Public transit service improvements are often justified, in part, as congestion reduction strategies, but there are debates concerning their effectiveness and value.

A recent study, *Transit Utilization and Traffic Congestion: Is There a Connection?* (Rubin and Mansour 2013) found a positive correlation between public transit utilization (per capita transit trips and passenger-miles) and traffic congestion (measured using the Travel Time Index) among 74 U.S. cities. The authors claim this indicates that transit improvements are an ineffective solution to congestion problems. Their results have been widely publicized.

These conclusions contrast with those of other studies which indicate that appropriate transit improvements do reduce traffic congestion. These discrepancies reflect differences in analysis methods and assumptions. Many factors affect transportation conditions so targeted analysis is required to accurately measure how individual system changes affect outcomes. Traffic congestion tends to maintain equilibrium, which is sometimes called the *Downs-Thomson Paradox* (Downs 1992). Delays increase until some potential peak-period vehicle trips are foregone. The level of congestion equilibrium is affected by the quality of alternatives: if alternatives are poor, travelers will drive even if congestion is severe, but if alternatives are attractive travelers will more easily forego peak-period vehicle trips, reducing the point of equilibrium. Even small shifts can provide significant benefits. For example, a 5% reduction from 2,000 to 1,900 vehicles per lane-hour typically increases roadway traffic speeds by 10 to 20 kilometers per hour. Highway congestion tends to decline as transit service improves on that corridor (Vuchic 1999; Williams and Lewis 1999). Congestion does not disappear, but is often much lower than what would otherwise occur. As a result, improving transit speed and frequency on congested urban corridors can reduce delays to both transit passengers and motorists on parallel highways.

Conventional evaluation methods tend to undervalue these benefits. For example, congestion intensity indicators, such as the Travel Time Index, ignore the congestion avoided when travelers shift modes or reduce trip lengths, and conventional urban traffic models are not very accurate at predicting how changes in transit service quality (convenience, speed and comfort) will affect vehicle traffic. There are confounding factors related to public transit utilization and congestion impacts. As a result, targeted analysis is required to accurately measure how transit service change impact congestion.

To their credit, Rubin and Mansour acknowledge some potential problems with their analysis, particularly controversies concerning use of the Travel Time Index. They also leave open the possibility that in some situations, transit improvements may reduce congestion. Tom Rubin and I have engaged in an ongoing dialogue that explores our issues of agreement and disagreement.

This report critiques Rubin and Mansour's study. It summarizes literature on public transit congestion impacts, critically evaluates their analysis methods, summarizes our preliminary research on the relationships between high-quality transit and congestion costs, and discusses related issues. This is part of on-going efforts by the Victoria Transport Policy Institute to improve our understanding of congestion costs and the effectiveness of potential congestion reduction strategies, as discussed in more detail in *Smart Congestion Relief: Comprehensive Evaluation Of Traffic Congestion Costs and Congestion Reduction Strategies* (Litman 2014).

Literature Review

There is an extensive technical literature on congestion costing methods (Grant-Muller and Laird 2007; TC 2006; Wallis and Lupton 2013), and the effectiveness of various potential congestion reduction strategies (Grant, et al. 2011; Litman 2014; Nelson\Nygaard 2006), particularly public transit improvements (Aftabuzzaman, Currie and Sarvi 2010; Anderson 2013; Bhattacharjee and Goetz 2012; Duranton and Turner 2011; Kim, Park and Sang 2008). Many of these studies indicate that high quality (frequent and grade-separated) transit service can reduce the intensity of congestion on parallel roadways, and by reducing total automobile trips can reduce per capita congestion costs.

The clearest evidence is provided by studies which measure the increased congestion that occurs when transit services stop temporarily. For example, Anderson (2013) found that average highway delay increased 47% in Los Angeles during the 2003 transit workers strike. Studying the same event, Lo and Hall (2006) found that roadway traffic speed reductions were particularly large on rail transit corridors, indicating that higher quality service is particularly effective for reducing congestion. These congestion increases were much larger than the region's 11% transit commute mode share, indicating that transit ridership is higher than average on the most congested urban corridors, resulting in proportionately large congestion impacts.

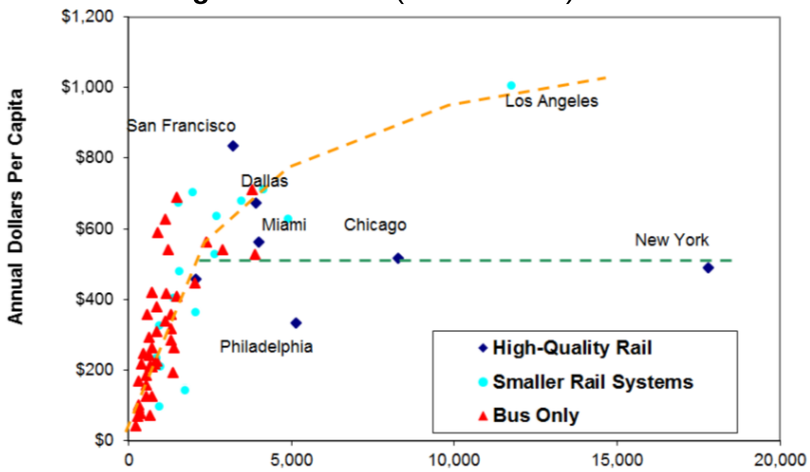
Some studies measure transit service improvement congestion impacts in a particular area. Bhattacharjee and Goetz (2012) found that Denver, Colorado traffic volumes grew less on roads in light rail corridors than elsewhere: between 1992 and 2008 vehicle-miles traveled increased 41% outside the light rail zones but only 31% inside, despite significant local development there. Following the Hiawatha LRT line's completion, Kim, Park and Sang (2008) found that peak-period vehicle traffic volumes on that corridor decreased while regional vehicle traffic grew. Liu (2005) found that after the San Fernando Valley Orange Line busway began operation in 2005, 101 Freeway peak-hour traffic speeds increased about 7% (from 43 to 46 average miles-per-hour), traffic speeds below 35 mph were 14% less frequent, and congestion began about 11 minutes later on average (from 6:55 a.m. to 7:06 a.m. on average).

Some studies evaluate how regional transit service improvements affect regional congestion. Garrett (2004) found evidence that transit slowed the growth in roadway congestion in some U.S. cities after they established light rail systems. Although all experienced congestion growth between 1980 and 2000, this growth tended to decline after the light rail systems started operation. For example, in Baltimore the roadway congestion index increased on average 2.8% annually before light rail service started in 1992, but only 1.5% after; Sacramento's congestion increased 4.5% annually before and 2.2% after light rail service started in 1987; St. Louis congestion increased 0.89% before and 0.86% after light rail service started in 1993; and Dallas experienced no change after rail service started in 1996. Similarly, Winston and Langer (2004) indicate that regional traffic congestion often declines as rail transit mileage expands.

Nelson, et al. (2006) used a regional transport model to estimate Washington, DC transit system benefits to users, and congestion-reduction benefits to motorists. They found that rail transit generates congestion-reduction benefits that exceed rail subsidies and the combined benefits of rail and bus transit significantly exceeds total transit subsidies. Their study overlooked other benefits such as parking cost savings, as well as crash and emission reduction benefits, and so understates total social benefits.

Litman (2004) found that cities with extensive grade-separated transit systems have lower per capita congestion costs than comparable size cities with lower quality transit services, so New York and Chicago have lower per capita congestion costs than Dallas and Los Angeles, as illustrated in Figure 1.

Figure 1 **Congestion Costs** (Litman 2004)



Traffic congestion costs tend to increase with city size (orange dashed line), except for cities with high-quality rail systems (green dashed line).

Aftabuzzaman, Currie and Sarvi (2010 and 2011) used factor analysis to identify and quantify three ways that high quality public transit reduces traffic congestion: (1) transit-oriented factor, (2) car-deterrence factor, and (3) urban-form factor. Regression analysis indicates that the car-deterrence factor makes the greatest contribution to reducing congestion, followed by transit-oriented factor and urban-form factor. They conclude that high quality transit provides $0.044 to $1.51 worth of congestion cost reduction (Aus$2008) per marginal transit-vehicle-km, with higher values when congestion is most intense. Duranton and Turner (2011) used detailed statistical analysis to evaluate the relationship between aggregate roadway and public transit supply and highway vehicle travel in us cities; they conclude that increasing transit supply is unlikely to relieve congestion.

Transit-oriented development (compact, mixed, walkable neighborhoods near transit stations) tends to reduce vehicle ownership and use: residents of such areas tend to own half as many vehicles and drive 20-60% less than average (Arrington and Sloop 2010). Even if increased density increases local congestion intensity, reduced automobile mode share and shorter trips can reduce regional congestion costs. Kuzmyak (2012) found that residents of urban neighborhoods with better travel options, more connected streets and more nearby services drive a third fewer daily miles and experience less per capita congestion delays than otherwise similar residents in automobile-dependent areas.

Table 1 **Factors That Increase Transit Ridership**

	Roadway Congestion	Non-Drivers Accessibility	Transit User Impacts
Increased population (city size) and employment rates	Increased		
Poverty (fewer residents can drive)	Reduced		Negative
Improved transit service (more service, grade separation, etc.)	Reduced	Improved	Benefits
Reduced transit fares	Small reduction	Improved	
Road pricing	Reduced		Mixed
Transit-oriented development	Reduced overall	Improved	Benefits

Various factors can increase transit ridership. Some, such as increased city size and employment, also tend to increase congestion, while others, such as improved transit service and road pricing, reduce congestion. Some factors also improve non-drivers' accessibility and directly benefit users. All these relationships should be considered when evaluating how changes in transit utilization affect congestion and overall benefits.

Critiquing Rubin and Mansour's Analysis

This section critically examines Rubin and Mansour's evaluation methods.

Selection of Congestion Indicators

There are various possible ways to measure traffic congestion (Grant-Muller and Laird 2007; Litman 2014; Wallis and Lupton 2013). Some, such as roadway level-of-service (LOS) and the Travel Time Index (TTI), measure congestion *intensity*, which is the reduction in vehicle traffic speed that occurs during peak periods. This information is useful for individuals making short-term travel decisions, such as how to travel across town during rush hour, but is unsuitable for strategic planning that affects congestion *exposure*, the amount that people must drive during peak periods. Planning decisions that affect the quality of travel options (such as the provision of grade-separated public transit service) or land use patterns (such as the location of public facilities such as schools) should be evaluated using congestion cost indicators, such as per capita traffic delays.

These different indicators can provide very different conclusion about the nature of congestion problems and the effectiveness of potential congestion reduction strategies. Compact, multi-modal cities such as New York, Boston and Philadelphia tend to have more intense congestion (greater peak-period speed reductions), but lower congestion costs (annul delay per commuter) due to lower auto mode shares and shorter trip distances. More dispersed, automobile-oriented cities such as Houston, Atlanta and Detroit tend to have less intense congestion but higher congestion costs. Compact cities rank worse if evaluated by congestion intensity indicators such as the Travel Time Index (TTI) but better if evaluated by congestion costs, as shown in Table 2.

Table 2 **City Rankings Change Depending On Indicators** (TTI 2013)

Congestion Intensity (Travel Time Index)	Congestion Costs (Delay Hours Per Commuter)
1. Los Angeles-Long Beach-Santa Ana CA (1.37)	1. Los Angeles-Long Beach-Santa Ana CA (44.9)
2. New York-Newark NY-NJ-CT (1.33)	2. Washington DC-VA-MD (44.3)
3. Washington DC-VA-MD (1.32)	**3. Houston TX (41.0)**
4. Boston MA-NH-RI (1.28)	**4. Atlanta GA 39.4)**
5. Houston TX (1.26)	5. San Francisco-Oakland CA (37.7)
6. Philadelphia PA-NJ-DE-MD (1.26)	6. Dallas-Fort Worth-Arlington TX (36.6)
7. Seattle WA (1.26)	**7. Miami FL (36.5)**
8. Dallas-Fort Worth-Arlington TX (1.26)	**8. Boston MA-NH-RI (36.3)**
9. Chicago IL-IN (1.25)	9. Chicago IL-IN (36.2)
10. Miami FL (1.25)	**10. Philadelphia PA-NJ-DE-MD (35.4)**
11. Atlanta GA (1.24)	11. Detroit MI (33.6)
12. San Francisco-Oakland CA (1.22)	12. Seattle WA (33.4)
13. Detroit MI (1.18)	**13. New York-Newark NY-NJ-CT (29.7)**
14. San Diego CA (1.18)	14. San Diego CA (28.0)
15. Phoenix-Mesa AZ (1.18)	15. Phoenix-Mesa AZ (26.7)

More compact urban regions (blue) tend to have more intense congestion but lower congestion costs per commuter than sprawled, auto-oriented regions (red). Rankings change depending on which congestion indicator is used.

Here are examples of how these different indicators can affect planning decisions.

- Converting a general traffic lane into a bus lane often reduces bus passenger delays but increases delay in the remaining traffic lanes. Congestion intensity indicators only measure vehicle traffic impacts, and so would conclude that congestion has increased, even if total per capita delay hours decline.
- Development policies that increase development density tend to increase congestion *intensity* but reduce congestion costs due to better alternatives to driving and shorter trip distances.

- A more central, infill location often experiences more intense local congestion than an urban fringe location, but lower congestion costs, since a central location offers better travel options (better walking, cycling and public transit access) and shorter trip distances.

Because Rubin and Mansour's analysis relies on a congestion intensity indicator, their conclusion that transit utilization is associated with "worse" traffic congestion is ambiguous; it would be more accurate for them to say that it is associated with more "intense" congestion, but more intense congestion does not necessarily mean higher congestion costs.

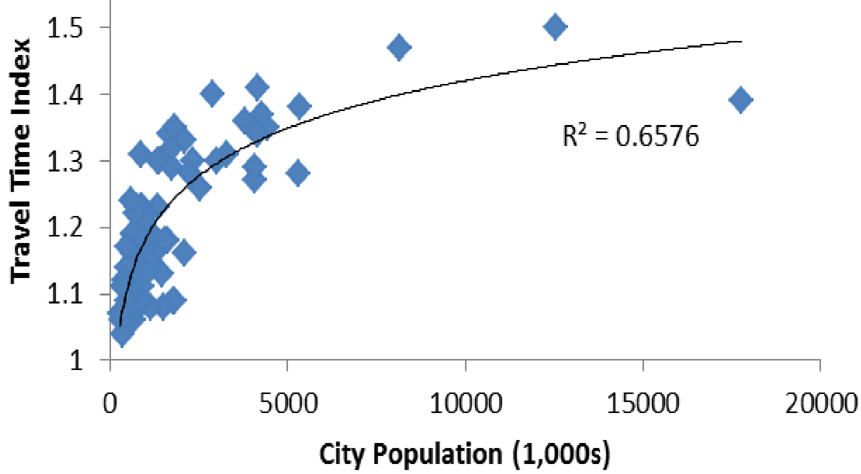
Rubin and Mansour acknowledge in an appendix that the Travel Time Index has been criticized. They state, "*While the UMR and TTI are certainly not without their critics, including those who disagree with certain aspects of how transit data are used for calculation of congestion statistics, we believe that the UMR is not "unfair" to transit and transit users.*" They then explain that because the American Public Transit Association has sponsored the Urban Mobility Report, "*any representation of the UMR as being unfit for use for evaluation of the impact of transit usage on traffic congestion due to an institutional bias against transit, or errors in data or methodology, is unsupportable.*" This reflects a political rather than technical perspective; it ignores the key issue, that congestion intensity indicators are unsuitable for strategic planning that affects travel options such as public transit service quality.

Rubin and Mansour further defend their use of the TTI by arguing that it is the most common and standard congestion indicator, implying that other indicators are difficult to apply, but the *Urban Mobility Report* and the *INRIX Congestion Scorecard* also provide congestion delay data, so it is possible to measure congestion costs as well as intensity, as demonstrated later in this report.

Failure to Account for Confounding Factors

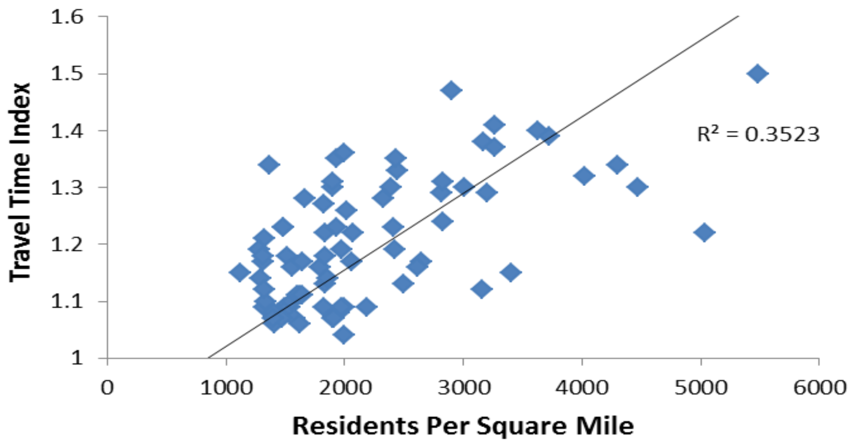
Another flaw in Rubin and Mansour's analysis is failure to account for confounding factors. Congestion intensity and transit use tend to increase with city size, density and employment rates, as illustrated in the following graphs. These relationships are quite strong, and so can explain the positive relationship between transit use and congestion intensity, yet are not discussed in the report.

Figure 2 **Travel Time Index Versus City Size** (VTPI 2009)



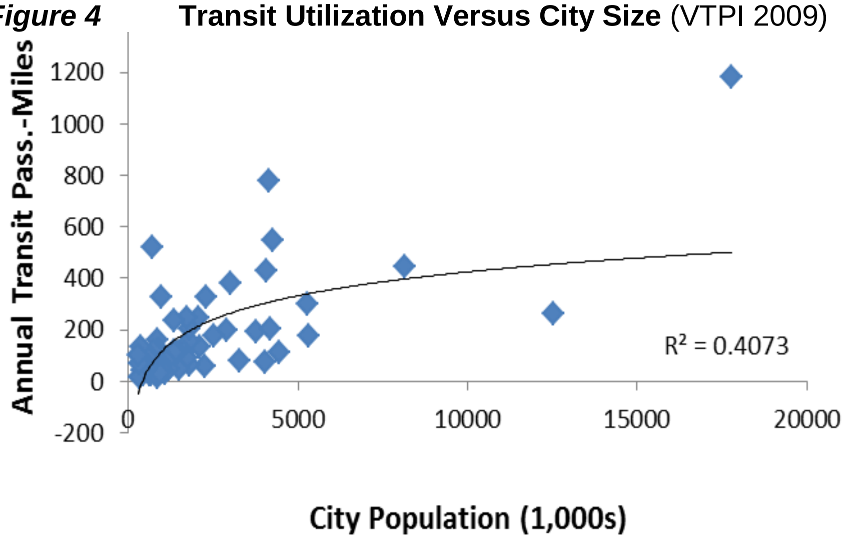
Traffic congestion intensity (measured by the Travel Time Index) tends to increase with city size.

Figure 3 **Travel Time Index Versus Density** (VTPI 2009)



Congestion intensity tends to increase with population density.

Figure 4 **Transit Utilization Versus City Size** (VTPI 2009)



Transit utilization (measured as transit passenger-trips or passenger-miles per capita) tends to increase with city size.

The positive relationship between transit utilization and congestion intensity identified in Rubin and Mansour's analysis can partly be explained by the tendency of roadway congestion to encourage use of grade-separated transit: as congestion increases such transit becomes more competitive with driving. To the degree this is true it is inappropriate to imply that public transit makes congestion "worse."

Transit Quality and Geographic Scale

Rubin and Mansour's analysis lumps together all types of transit, and evaluates impacts at a regional scale, although only higher-quality, grade separated service on major urban corridors is expected to reduce congestion. Since most public transit service in most cities consists of buses in mixed traffic intended to provide basic mobility, including all transit dilutes the congestion reduction effects of appropriate transit services. It is therefore unsurprising that the report's analysis finds little evidence that transit utilization reduces regional congestion.

Research Practices

Good research reports provide comprehensive information to help readers understand a study's context, including detailed literature reviews, explanations of why particular analysis methods and assumptions were selected, discussion of potential omissions and biases, and sensitivity analysis to explore how different methods or assumptions would affect results. Rubin and Mansour ignore these practices; they provide no review of technical publications concerning traffic congestion evaluation methods, or summaries of previous transit congestion impact studies. Most of their references are political documents. They include little discussion of potential biases and no sensitivity analysis. As a result, readers have no context or guidance for understanding the report's analysis.

Ongoing Dialogue

In our ongoing dialogue (Rubin and Litman 2014), Mr. Rubin acknowledged many of these criticisms of his analysis. For example, he agreed that the possible conversion of a general traffic lane into a bus lane should be evaluated based on changes in total travel times (including bus passenger time savings) even if automobile traffic speeds decline, indicating he agrees that congestion should be evaluated based on costs rather than intensity. Similarly, I offered the following criticism of his analysis:

> "Another flaw is the study's failure to account for confounding factors, particularly city size. Urban region size, development density, transit service, transit ridership and traffic congestion intensity all tend to increase together, so it is unsurprising to find positive correlations between any two. It is unfair to compare congestion intensity between urban areas without accounting for such factors." (and) "Your statement, 'changes in congestion,' is unspecific. Does it mean changes in congestion intensity, changes in congestion costs per motorist, or changes in congestion costs per capita? In fact, you are referring to congestion intensity, not congestion costs, because your analysis relies on the Travel Time Index, the amount that traffic speeds decline during peak periods. Congestion intensity indicators are useful for making short-term planning decisions, such as how to travel across town during rush hour, but are unsuited for strategic planning decisions that affect the quality of travel options available during peak periods, or land use decisions that affect the distances people must travel, and therefore their exposure to congestion."

In response, Rubin acknowledged, "most of the above statements are not inaccurate and have merit." He then defends their use of the Travel Time Index without addressing these criticisms.

Rubin raises other, general criticisms of public transit. He argues that public transit is inefficient and harms economically disadvantaged commuters because transit commutes take longer on average than automobile commutes and many worksites are difficult to access by transit. Such criticisms are backward: transit service improvements (particularly increased frequency, grade separation, and transit-oriented development that increases the proximity of destinations to transit stations) can reduce transit travel times and increase transit job access (CTS 2010), reducing the disparity between transit and automobile commute duration. The problems he cites are justifications for more rather then less emphasis on public transit improvements.

Mode choice decisions often involves various trade-offs between time, comfort, and money costs; if transit improvements cause commuters to shift from auto to transit, they must be better off overall, even if their travel speeds decline, or they would not change; the additional time is offset by user benefits such as the ability to rest and work while commuting, or financial savings, particularly if transit improvements allow a household to reduce vehicle ownership (residents of communities with high quality public transit have much lower vehicle ownership rates than in automobile-dependent communities, as discussed by Arrington and Sloop 2010). For an average household, the net savings from shedding a vehicle equals or exceeds incremental travel time costs for the lowest three income quintiles (fifth of the population) if time is valued at full wages, and provide net savings to all quintiles if valued at 50% of average wages (USDOT 2011), as illustrated in the following table.

Table 3 **Public Transit Effective Time Savings By Income Quintile** (BLS 2012)

	Lowest	Second	Third	Fourth	Highest
Average annual income before taxes	$9,805	$27,117	46,190	74,019	161,292
Earners per household	0.5	0.9	1.3	1.7	2.0
Hourly income (assuming 2000 hrs/yr)	$9.81	$15.07	$17.77	$21.77	$40.32
Annual motor vehicle expenditures	$3,074	$4,938	$7,225	$9,730	$13,912
Vehicles/household	1.00	1.50	1.90	2.30	2.80
Annual expenditure per vehicle	$3,074	$3,292	$3,803	$4,230	$4,969
Annual net savings, assuming $1,000 non-auto expenses	$2,074	$2,292	$2,803	$3,230	$3,969
Annual work hours avoided from one fewer vehicles	212	152	158	148	98
Hours saved per workday	1.06	0.76	0.79	0.74	0.49
Incremental daily transit commute time (48 min.)	0.80	0.80	0.80	0.80	0.80
Incremental savings/transit commute time	1.3	1.0	1.0	0.9	0.6
Incremental savings/time valued at 50% wages	2.6	1.9	2.0	1.9	1.2

If public transit improvements allow households to reduce vehicle ownership, average net financial savings exceed the average incremental travel time costs for the three lowest income quintiles (fifth of population) if time is valued at wages, and for all quintiles if valued at 50% of wages as is common for economic evaluation.

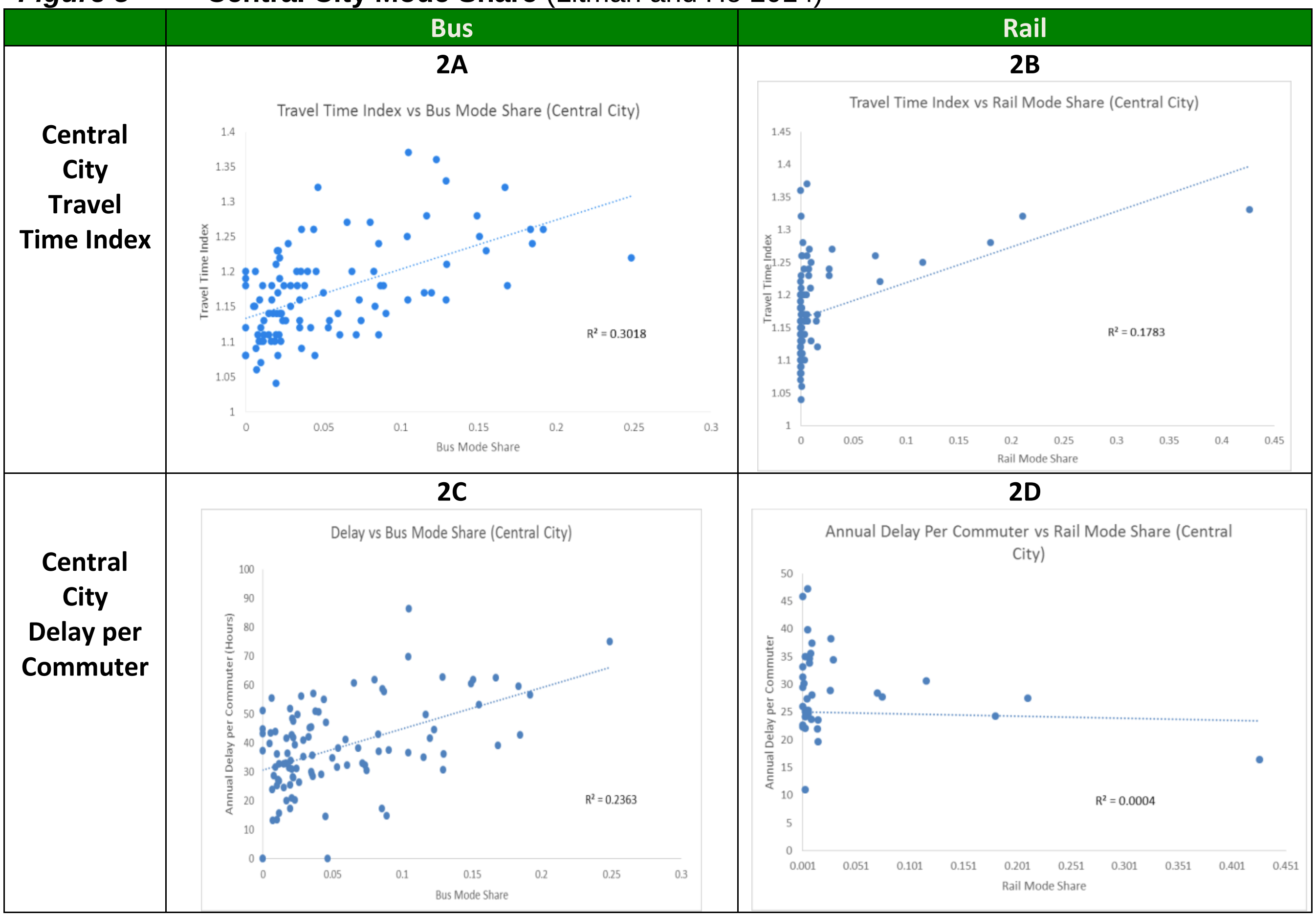
Rubin also argues that transit is costly and subsidized but fails to compare these with costs and subsidies required to accommodate additional automobile travel under the same conditions. Expanding urban highways typically costs more than $1.00 per additional peak-period vehicle accommodated, and providing an urban parking space often costs $5-20 per day (Decorla-Souza and Jensen-Fisher 1997; Litman 2009). Under such conditions, transit trips are often cheaper overall, and since transit users generally travel fewer annual miles than motorists, per capita costs and subsidies are generally lower for transit users than motorists.

Ruben argues, often passionately with detailed examples and personal stories from his forty-year career working for transit agencies, that urban planners and transit advocates exaggerate transit demand and potential benefits. To understand his criticism it is important to consider the political context. Conventional planning evaluates transport system performance based primarily on vehicle travel speeds and congestion delay, using indicators such as roadway level-of-service, traffic speed and delay. As a result, the planning process gives significant weight to congestion impacts and little consideration to many transit benefits such as parking cost savings, consumer savings, mobility for non-drivers, and various health benefits. Many practitioners, officials and citizens support transit more than justified by conventional evaluation; they realize intuitively that transit provides greater benefits than conventional benefit/cost analysis indicates. Because congestion reduction is such a dominant objective, transit advocates provide optimistic ridership and benefit projections. Much of Rubin's career occurred during the period when transit demand was declining and ridership often failed to meet projections.

New Research Preliminary Results

As part of the Victoria Transport Policy Institute's ongoing research into congestion impact analysis, my colleague, John Ho and I have begun comprehensive analysis of the relationships between transit use and congestion (Litman and Ho 2014). We measured correlations between bus and rail mode share and congestion measured using the Travel Time Index and annual delay hours per commuter (the *Urban Mobility Report* provides delay hours per automobile commuter, which we multiplied by auto commute mode share). Since transit ridership tends to be higher than average on major urban corridors that experience the most congestion, central city mode share is probably a good indication of mode shares on a region's most congested urban corridors. The following graphs illustrate our preliminary results.

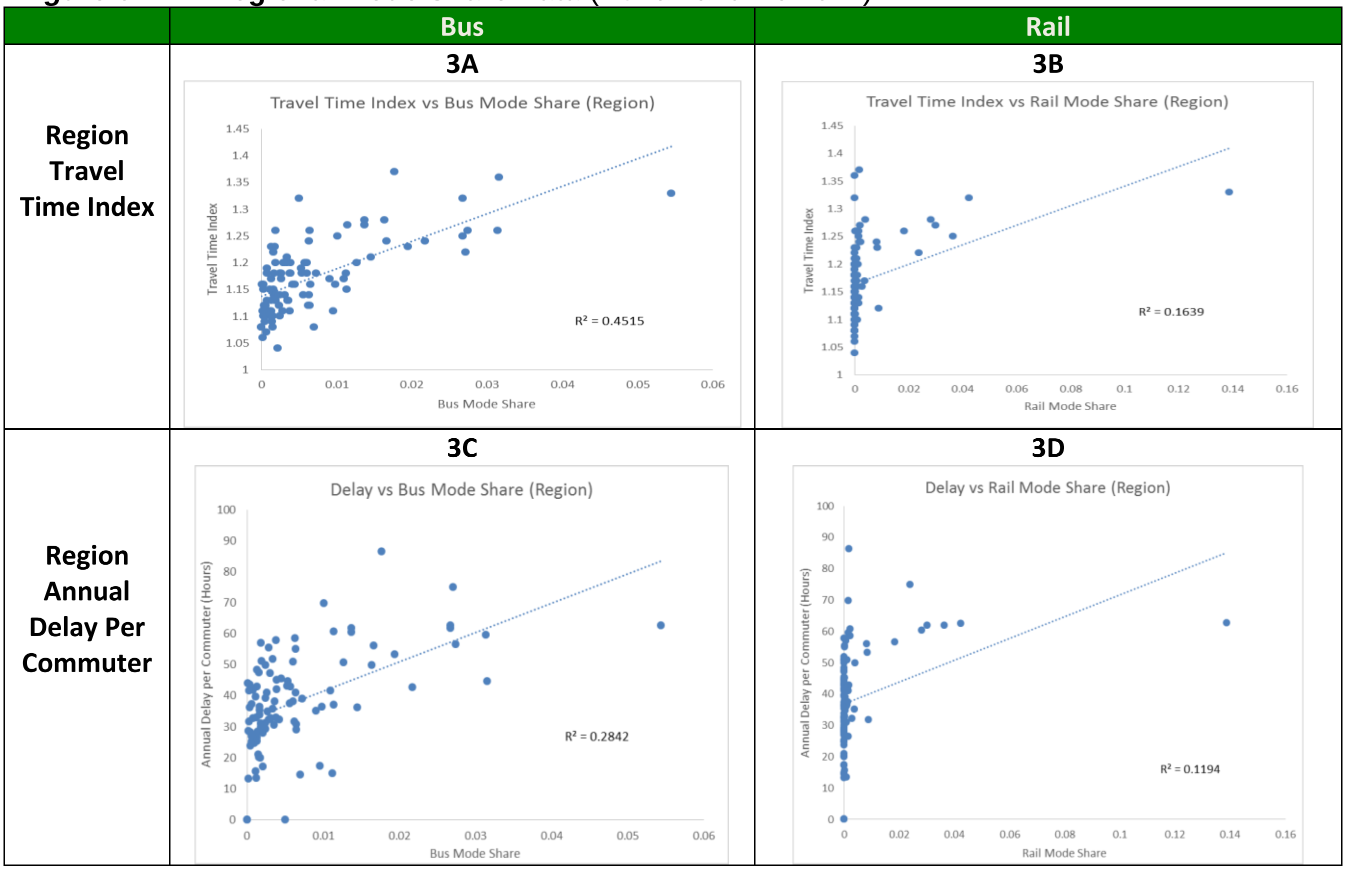
Figure 5 **Central City Mode Share** (Litman and Ho 2014)



These graphs illustrate the relationships between central city congestion indicators and transit mode share. Each dot represents a city.

This analysis does not correct for all the factors discussed in this critique. It does not account for city size, density or employment rates, uses rail as an indicator of transit service quality (some bus services have relatively high quality and some rail has relatively poor quality), and reflects regional rather than corridor-level analysis (although some of this analysis uses central city mode share as an independent variable, regional congestion is the dependent variable). We hope to perform future research using multi-factor regression analysis that accounts for these factors.

Figure 6 **Regional Mode Share Data** (Litman and Ho 2014)



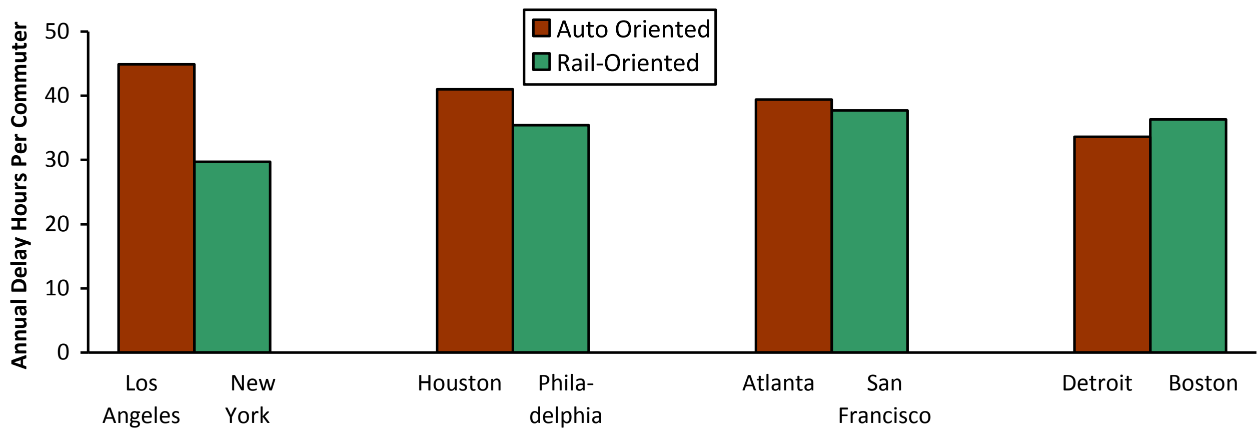
These graphs illustrate the relationships between regional congestion indicators and transit mode share. Each dot represents an urban region.

These results are consistent with our understanding of the relationships between transit and congestion:

- The correlation is overall positive: cities with more transit use tend to have more congestion. This can be explained by confounding factors: transit use, congestion, city size, density and employment rates are all positively correlated.
- The correlation is stronger for buses than for rail. This can be explained by the relative ineffectiveness of bus at reducing congestion compared with rail, which tends to provide higher quality service. As a result, rail tends to off-set the confounding factors (for a given size, cities with more rail use have less congestion).
- The correlation is stronger for congestion intensity (Travel Time Index) than congestion costs (per commuter delay). This can be explained by the fact that intensity indicators do not account for the delays avoided by travelers who use non-automobile modes and from more compact development (cities with more rail use have more intense congestion but less delay per capita).
- Annual delay per commuter is negatively correlated with central city rail mode share (increased central city rail commuting is associated with reduced regional congestion delay). This can be explained by the fact that this is the type of transit most likely to reduce congestion. Although the relationship is weak, it suggests that rail transit can offset confounding factors such as city size and density.

Figure 7 illustrates the results of matched pair analysis, which compares congestion costs of similar size cities. This analysis indicates that in most cases the automobile-oriented cities (Los Angeles, Houston and Atlanta) have greater congestion delay per commuter than similar size cities that have high rail transit ridership (New York, Philadelphia and San Francisco). An exception is Detroit, which has slightly less congestion than similar size Boston.

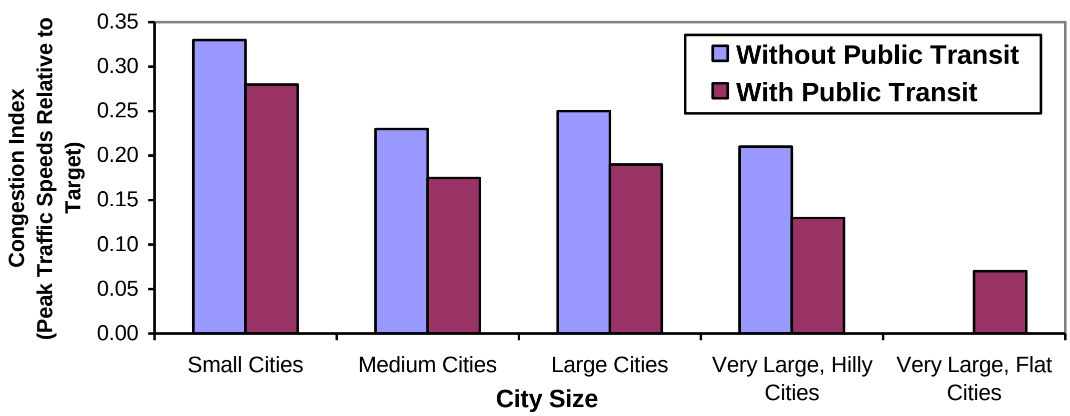
Figure 7 **Matched Pair Analysis** (Litman and Ho 2014)



Matched pair analysis compares congestion delay per commuter between similar size cities. Auto-oriented cities tend to have more congestion delay than those with significant rail transit mode shares.

Of course, other factors affect congestion including population and economic growth rates (most of these cities are growing, Detroit is contracting, which helps explain its relatively low congestion delay), and through traffic volumes on regional roads (all of these cities besides Atlanta and Detroit are major international ports). However, this does suggest that residents of cities with high mode share of grade-separated transit (rail or buses in their own rights-of-way) have significantly less congestion delay compared with what would otherwise occur. Similar patterns are found in developing countries. Figure 8 shows that Indian cities which lack rail transit have more intense roadway congestion than those with rail transit systems. These studies indicate that high quality transit does tend to reduce congestion.

Figure 8 **Traffic Congestion in India** (Wilbur Smith 2008)



Traffic congestion is lower in Indian cities with higher quality public transit.

Conclusions

There is considerable, sometimes contentious debate concerning the effectiveness and value of public transit improvements. Many transit projects are justified, in part, by predicted traffic congestion reductions, but critics argue that such benefits are exaggerated.

Several studies using various methods and data sets find that high quality, grade-separated transit service can reduce traffic congestion. The clearest evidence is provided by studies which measure the congestion increases that occur when transit service suddenly stops, and those that compare congestion on roadways with-and-without or before-and-after high-quality transit is established. Matched pair analysis also indicates that per commuter congestion delay is lower in transit-oriented cities such as New York, San Francisco and Boston than in similar-size automobile-dependent cities such as Los Angeles, Houston and Atlanta.

Other studies attempt to discern impacts using aggregated regional data. Such analysis is challenging because many factors affect transit ridership and congestion levels, including roadway supply and design, through traffic volumes, road and parking pricing, city size and growth, development density and mix, and economic activity. Also, roadway congestion tends to encourage ridership of grade separated transit. Results also vary depending on whether impacts are measured using indicators of congestion intensity or of congestion costs. As a result, it is unsurprising that such studies find a positive correlation between transit utilization and congestion intensity.

Rubin and Mansour found positive correlations between transit utilization (per capita transit trips and passenger-miles) and Travel Time Index ratings for 74 U.S. urban regions. They claim this proves that transit fails to reduce congestion. However, their analysis reflects omissions and biases, summarized in Table 4.

Table 4 **Summary Analysis Best Practices and Rubin and Mansour's Biases**

Analysis Factor	Best Practices	Omissions and Bias
How congestion is measured	Measure congestion cost indicators which account for the congestion avoided by grade-separated transit users, rather than congestion intensity indicators which only consider impacts on motorists.	Rubin and Mansour use the Travel Time Index, which only measures impacts on motorists; it ignores the congestion costs avoided by travelers who shift from driving to grade-separated transit.
Confounding factors	Since transit ridership and congestion both tend to increase with city size, density, and employment, the analysis should account for these factors, by using multivariate regression of matched pair analysis of similar size cities.	They fail to account for confounding factors, so their results are unsurprising but inaccurate; they simply confirm that both congestion intensity and transit ridership increase with city size, density and employment rates.
Transit service quality	Only high-quality transit (relatively convenient, comfortable and fast, which generally requires grade-separation) on major urban corridors is expected to reduce congestion.	Their analysis includes all transit use, rather than focusing on high quality transit on major corridors, which is the type of transit expected to reduce congestion.

Rubin and Mansour's analysis includes several significant omissions and biases which tend to underestimate the congestion reduction benefits provided by high-quality transit on major urban corridors.

Rubin and Mansour's report also fails to reflect basic research principles; it includes no technical literature review that would place their study into the larger context of research on this subject, it does not discuss analysis limitations and possible biases, it does not test how results change with different analysis methods and assumptions, and was not peer reviewed.

Whether by accident or intent, Rubin and Mansour's methods and assumptions reflect the most pessimistic analysis of transit congestion reduction impacts, and their report provides no context to help readers understand why their results differ from other studies of transit congestion impacts. Their report is a political document, intended to promote a particular outcome, rather than an objective study to provide useful policy guidance. Their arguments can be understood as a counter to what they consider transit advocate's exaggerated congestion reduction predictions. Their criticism may be partly justified; advocates have over-predicted transit ridership or the congestion reduction benefits from basic bus services. On the other hand, such exaggerations may be justified overall to correct for transport planning biases which place excessive weight on congestion reductions and undervalue other transit benefits such as parking cost savings, consumer savings and benefits, improved mobility for non-drivers, plus health and safety benefits (Litman 2013). More comprehensive transit benefit analysis could reduce the pressure on advocates to exaggerate congestion reductions. This will require better models for predicting how specific transport system changes can affect transit ridership, and comprehensive analysis of resulting economic, social and environmental benefits.

The majority of transit in most communities consists of basic bus service intended to provide basic mobility for non-drivers. Such services do little to reduce traffic congestion. Only high-quality services that attract discretionary travelers (people who would otherwise drive) on congested urban corridors are expected to significantly reduce congestion. Rubin and Mansour's research can therefore be interpreted as a justification for improving public transit service quality, particularly more grade separation (bus lanes and grade-separated rail) to maximize congestion reductions and other benefits.

To their credit, in their report and in subsequent dialogues (Rubin and Litman 2014), Rubin and Mansour acknowledge some problems with their analysis. Their report even cites one of my publications, and concedes that transit improvements may sometimes reduce congestion and be justified for other reasons not considered in their analysis. I appreciate Rubin's willingness to engage in these discussions. However, what is important are the insights they offer others who want to understand the role transit can play in creating efficient and equitable transport systems.

If you ask, as do Rubin and Mansour, "Do marginal increases in overall transit ridership reduce traffic congestion," the answer is generally, *not much*. Traffic congestion tends to maintain equilibrium, it increases to the point that travelers forego some potential per-period automobile trips: modest increases in transit ridership do little to reduce peak-period vehicle traffic. However, there is good research indicating that high quality (convenient, frequent, grade separated, comfortable and integrated) transit can reduce the point of congestion equilibrium. Congestion doesn't disappear, but is less than would otherwise occur. Testing this hypothesis requires measuring the impacts of high quality transit on specific roadways, accounting for confounding factors such as city size and employment rates. Such research, published in peer reviewed journals, does indicate that appropriate transit improvements do significantly reduce congestion costs compare with what would otherwise occur, and these benefits tend to increase if transit is implemented with supportive policies that encourage urban-peak travelers to shift from automobile to transit. As a result, even people who do not currently use public transit have good reasons to support transit improvements and encouragement programs.

As a result of omissions and biases in their analysis, Rubin and Mansour's study provides no guidance for answering key policy questions such as whether public transit improvements can help reduce congestion problems, what level of transit service is optimal, and what policies can maximize the value of public transit investments.

References

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. Also see, "Exploring The Underlying Dimensions Of Elements Affecting Traffic Congestion Relief Impact Of Transit," *Cities*, Vol. 28, Is. 1 (www.sciencedirect.com/science/journal/02642751), February 2011, Pages 36-44.

Michael L. Anderson (2013), *Subways, Strikes, and Slowdowns: The Impacts of Public Transit on Traffic Congestion*, Working Paper 18757, National Bureau of Economic Research (www.nber.org); at www.nber.org/papers/w18757.

G.B. Arrington and Kimi Iboshi Sloop (2010), "New Transit Cooperative Research Program Research Confirms Transit-Oriented Developments Produce Fewer Auto Trips," *ITE Journal* (www.ite.org), Vol. 79, No. 6, June, pp. 26-29.

Sutapa Bhattacharjee and Andrew R. Goetz (2012), "Impact Of Light Rail On Traffic Congestion In Denver," *Journal of Transport Geography*; abstract at www.sciencedirect.com/science/article/pii/S0966692312000129.

BLS (2012), *2011 Consumer Expenditure Survey*, Bureau of Labor Statistics (www.bls.gov/cex/csxstnd.htm).

Joe Cortright (2011), *UMR Remains a Flawed and Misleading Guide to Urban Transportation*, CEOs for Cities (www.ceosforcities.org); at www.ceosforcities.org/blog/2010-umr-remains-a-flawed-and-misleading-guide-to-urban-transportation.

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/research.

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

Anthony Downs (1992), *Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*, The Brookings Institution; in http://en.wikipedia.org/wiki/Downs%E2%80%93Thomson_paradox.

Gilles Duranton and Matthew A. Turner (2011), "The Fundamental Law of Highway Congestion: Evidence from the US," *American Economic Review* (www.aeaweb.org); at www.nber.org/papers/w15376 and www.economics.utoronto.ca/public/workingPapers/tecipa-370.pdf.

Yonah Freemark (2010), *Transit Mode Share Trends Looking Steady; Rail Appears to Encourage Non-Automobile Commutes*, The Transit Politic (www.thetransportpolitic.com); at www.thetransportpolitic.com/2010/10/13/transit-mode-share-trends-looking-steady-rail-appears-to-encourage-non-automobile-commutes.

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.

Michael Grant, et al. (2011), *Congestion Management Process: A Guidebook*, DTFH61-09-Q-00083, Federal Highway Administration (www.fhwa.dot.gov); at www.fhwa.dot.gov/planning/congestion_management_process/cmp_guidebook/cmpguidebk.pdf

Susan Grant-Muller and James Laird (2007), *International Literature Review of the Costs of Road Traffic Congestion*, Scottish Executive (www.scotland.gov.uk); at www.scotland.gov.uk/Publications/2006/11/01103351/0.

INRIX Congestion Scorecard (http://scorecard.inrix.com/scorecard).

Changchoo Kim, Yong-Seuk Park and Sunhee Sang (2008), *Spatial and Temporal Analysis of Urban Traffic Volume*, 2008 ESRI International User Conference; at http://gis.esri.com/library/userconf/proc08/papers/papers/pap_1613.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.

Kara Kockelman (2011), "Traffic Congestion," Ch. 22, *Transportation Engineering Handbook*, McGraw Hill (www.mhprofessional.com); at www.ce.utexas.edu/prof/kockelman/public_html/congestionchapter.pdf.

J. Richard Kuzmyak (2012), *Land Use and Traffic Congestion*, Report 618, Arizona DOT (www.azdot.gov); at www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ618.pdf.

Jonathan Levine, Joe Grengs, Qingyun Shen and Qing Shen (2012), "Does Accessibility Require Density or Speed?" *Journal of the American Planning Association*, Vol. 78, No. 2, pp. 157-172 (www.planning.org); at www.connectnorwalk.com/wp-content/uploads/JAPA-article-mobility-vs-proximity.pdf.

David Lewis and Fred Williams (1999), *Policy and Planning as Public Choice*, Ashgate (www.ashgate.com); at www.fta.dot.gov/documents/Policy_and_Planning_as_Public_Choice.pdf.

Todd Litman (2001), "Generated Traffic; Implications for Transport Planning," *ITE Journal*, Vol. 71, No. 4, April, pp. 38-47, ITE (www.ite.org); at www.vtpi.org/gentraf.pdf.

Todd Litman (2004), *Rail Transit in America: Comprehensive Evaluation of Benefits*, VTPI (www.vtpi.org); at www.vtpi.org/railben.pdf; summarized in "Impacts of Rail Transit on the Performance of a Transportation System," *Transportation Research Record 1930*, Transportation Research Board (www.trb.org), pp. 23-29.

Todd Litman (2008), "Valuing Transit Service Quality Improvements," *Journal of Public Transportation*, Vol. 11, No. 2, Spring, pp. 43-64; at www.nctr.usf.edu/jpt/pdf/JPT11-2Litman.pdf and www.vtpi.org/traveltime.pdf.

Todd Litman (2009), *Transportation Cost and Benefit Analysis*, VTPI (www.vtpi.org/tca).

Todd Litman (2013), *Evaluating Public Transit Benefits and Costs*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tranben.pdf.

Todd Litman (2014), *Smart Congestion Relief: Comprehensive Evaluation Of Traffic Congestion Costs and Congestion Reduction Strategies*, VTPI (www.vtpi.org); at www.vtpi.org/cong_relief.pdf. Also see "Smarter Congestion Relief In Asian Cities: Win-Win Solutions To Urban Transport Problems," *Transport and Communications Bulletin for Asia and the Pacific*, No. 82; at www.unescap.org/ttdw/Publications/TPTS_pubs/bulletin82/b82_Chapter1.pdf.

Todd Litman and John Ho (2014), *Transit Congestion Impact Analysis Spreadsheet*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/con_spreadsheet.xls.

Caitlin Liu (2005), "Orange Line Eases A.M. Rush on 101 Freeway: Study Finds A Slight Improvement In Traffic Flow Since The Opening Of The Valley Busway," *Los Angeles Times* (www.latimes.com), 30 Dec.

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), Dec., pp. 903-917.

Nelson\Nygaard (2006), *Traffic Reduction Strategies Study*, report and various appendices, City of Pasadena (www.cityofpasadena.net); at www.cityofpasadena.net/councilagendas/2007%20agendas/Feb_26_07/Pasadena%20Traffic%20Reduction%20Strategies%2011-20-06%20DRAFT.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.

Thomas A. Rubin and Fatma Mansour (2013), *Transit Utilization and Traffic Congestion: Is There a Connection?*, Reason Foundation (www.reason.org); at http://reason.org/files/transit_utilization_traffic_congestion.pdf.

Thomas A. Rubin and Todd Litman (2014), *Transit Congestion Impact Evaluation Debate*, Transport Policy Discussion Group; at www.vtpi.org/R&L_debate.pdf.

TC (2006), *The Cost Of Urban Congestion In Canada*, Transport Canada (www.tc.gc.ca); at www.adec-inc.ca/pdf/02-rapport/cong-canada-ang.pdf.

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

USDOT (2011), *Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations*, USDOT (www.usdot.gov); at www.dot.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf.

VTPI (2009), *Urban Transit Performance Spreadsheet*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/Transit2009.xls.

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

Ian Wallis and David Lupton (2013), *The Costs Of Congestion Reappraised*, Report 489, New Zealand Transport Agency (www.nzta.govt.nz); at www.nzta.govt.nz/resources/research/reports/489/docs/489.pdf.

Wilbur Smith (2008), *Traffic & Transportation Policies and Strategies in Urban Areas in India*, Ministry of Urban Development (www.urbanindia.nic.in); at http://urbanindia.nic.in/moud/programme/ut/Traffic_transportation.pdf.

www.vtpi.org/R&M_critique.pdf