A NOTE ON RAIL TRANSIT COST-BENEFIT ANALYSIS:

DO NON-USER BENEFITS MAKE A DIFFERENCE?

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ABSTRACT

Rail transit systems in modern American cities typically underperform. In light of high costs and low ridership, the cost-benefit results have been poor. But advocates often suggest that external (non-rider) benefits could soften these conclusions. In this paper we include recently published estimates of such non-rider benefits in the cost-benefit analysis. Adding these to recently published data for costs and ridership, we examine 34 post-World War II U.S. rail transit systems (8 commuter rail, 6 heavy rail and 20 light rail). The inclusion of the non-rider benefits does not change the negative assessment. In fact, sensitivity analyses that double the estimated non-rider benefits and/or double transit ridership also leave us with poor performance readings. Advocates who suggest that there are still other benefits that we have not included (always a possibility) have a high hurdle to clear.

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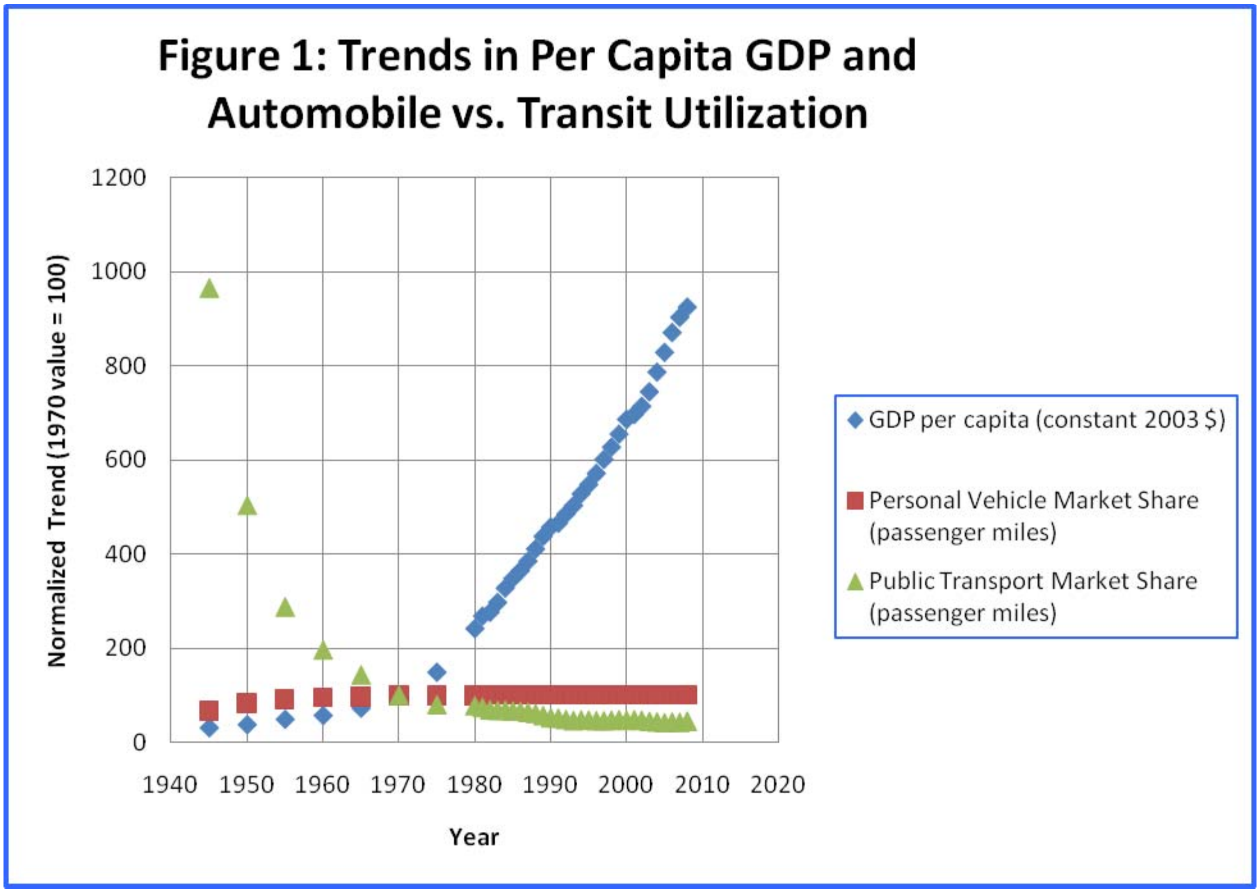
DO NON-USER BENEFITS MAKE A DIFFERENCE?

> A transportation program for the Los Angeles Metropolitan Area must be both adaptable and realistic. … Urban planning is being subjected to much critical appraisal today, particularly as a result of the impact of rapidly changing technology in transportation. Most of the transport planning for the older metropolitan centers, with their highly concentrated central business districts, projects a continuation to 1980 of past trends, with particular emphasis on the central business district and the need to preserve its present status and function. Even in Los Angeles, with its radically different structure, this objective seems to be the prime motivation of the proponents of rapid transit. Their planning savors of an endeavor to turn back the clock to an earlier period of transport technology, ignoring thereby the developments of the past forty years. Unless the centrifugal influence of transportation can be eliminated or severely restricted, the rapid transit scheme will most likely be futile, and it will certainly be expensive. (Dudley F. Pegrum, 1964, pp 41-42)

Prof Pegrum was right about Los Angeles and also about the other U.S. metropolitan areas. They are all in the automobile age; they are all subject to auto-oriented development; none of them are subject to significant refashioning via the introduction of high capacity rail transit systems. As incomes rise, people everywhere prefer the range and mobility of personal transportation. And as more people own cars, origins and destinations disperse. Then as cities spread out, the demand for cars is boosted – and the demand for transit falls. It is no surprise that the plurality of commuting in the U.S. has been suburb-to-suburb, since at least 2000 (Pisarski, 2007). Figure 1 summarizes these basic ideas, where the three variables have been normalized so that 1975 values equal 100. Nevertheless, these conclusions have not been widely accepted. Since Pegrum wrote, a large number of rail transit systems have been introduced into American cities. Their performance record corroborates Pegrum's view. And almost a half century later, Clifford Winston (2010) noted, "… I argue that urban transit's financial and service problems are attributable to public policies that have not effectively responded to changes in residential and firm locations and in household commuting patterns." (p. 64).



Notes: (1) Personal vehicle and public transport market shares from http://www.publicpurpose.com/ut-usptshare45.pdf;

(2) National transit use data may be misleading because the New York City transit system accounts for about one-third of the nation's urban bus riders and about two thirds of the nation's rail transit riders (Winston, 2010)

Various studies over the last 30 years have reached a similar conclusion. The performance of many of the recent U.S. rail transit systems is again analyzed in the pages that follow, but unlike the previous studies, we attempt to include non-user benefits in our cost-benefit analysis. We show that it makes very little difference. These transit systems remain uneconomic across the board.

PREVIOUS STUDIES

One of the earliest studies of actual vs. promised performance for U.S. post-WW- II-vintage rail transit systems was by Don Pickrell (1992). He analyzed eight heavy-rail projects (Washington DC, Atlanta, Baltimore, Miami) and eight light-rail projects (Buffalo, Pittsburgh, Portland, Sacramento). Pickrell reported across-the-board ridership shortfalls. "Only Washington's extensive Metrorail system experiences actual ridership that is more than one-half of its forecast." (p. 160) Looking for system-wide impacts (how many new-to-transit riders), Pickrell noted, "… actual ridership on bus and rail service together is below its forecast level in six of seven urban areas, most often by a substantial margin. (Baltimore had no forecast of total ridership.)" (p. 161). There were similar disappointments when actual vs. forecast costs were compared. On the cost theme, Flyvbjerg, et al. (2002) considered nineteen North American rail projects and found that, "[F]or rail projects, actual costs are on average 41% higher than estimated costs (sd=37)." (p. 290). Baum-Snow and Kahn (2005) studied fourteen U.S. metro areas that added rail transit in the years 1970-2000, but which did not have such systems previously. The authors tallied the fraction of transit commuters among workers who do not work at home and whose residence was within 25 miles of the central business district. For these fourteen cases, the average of transit commuters in 1970 was 6 percent but fell to 2 percent in 2000. For the group of seven metro areas studied that already had rail transit in 1970, the proportion fell from 30 percent to 23 percent. Winston and Maheshri (2007) studied 25 U.S. rail transit systems and compared transit agency deficits associated with rail transit operations with estimated users' consumer surpluses. They found that the agency deficits were far larger, denoting social inefficiencies.

The most recent U.S. rail transit study is by O'Toole (2010). He assembled data for seventy transit systems, including automated guideway, cable car, commuter rail, heavy rail, light rail and streetcar. The author carried out six tests (profitability, ridership, "cost-effectiveness," "cable car test … do rail lines perform as well as cable cars?", economic development test, transportation network test) but found that, "No system passes all of these tests, and in fact few of them pass any of the tests at all." (p. 1) O'Toole defined "cost-efficiency" as "… the number of buses needed to provide equivalent service to the rail lines …" (p. 9).

A COST-BENEFIT TEST

In this study, we analyzed 34 U.S post-WW II-vintage rail transit systems, eight commuter rail (CR), six heavy rail (HR) and 20 light rail (LR). We applied a standard benefit-cost test, whereby capital costs are annualized and combined with annual data for each line. The basic data are shown in Table A1a of the Appendix. We used the capital cost data for each line as reported by O'Toole and applied all of the other required data from the Federal Transit Administration's (FTA) National Transit Data Base. We restricted the analysis to cases for which data from both sources were available. All dollar values were converted to 2009 dollars.

Capital costs were annualized in the manner recommended by the FTA. They suggest a seven percent per annum capitalization rate.[1] To be sure, Tom Rubin (2010) reminded us that these systems actually incur capital expenditures every year for renewal and replacement of existing transit systems. This is an important caveat to the presumption that we have captured all of the capital costs. Taking the aggregate of FTA's reported transit system capital expenditures for any one year is a useful approach if a system-by-system analysis is not required. In that case, the analyst presumes that the various systems in the sample are at various stages of their life cycle and the sum of all of the capital expenditures for that year is an accurate reflection of that year's system-wide capital costs.

Annual passenger boardings and annual operating expenditures for each of the 34 systems were available from the FTAs National Transit Data Base. Average trip lengths and average

[1] http://www.fta.dot.gov/planning/newstarts/planning_environment_2580.html. Thirty years at 7 percent suggests applying 8.06 percent to the capital cost estimate.

fares for the three rail transit types were calculated from American Public Transit Association data and shown in Appendix Table A2.

We augmented these conventional measures by attempting to account for non-user benefits. These would be due to auto trips avoided by any new-to-transit passengers. While most riders on new rail transit systems were former bus users, Rubin's compilation of new-rider percentages in recent "new starts" rail transit applications suggests that slightly more than 25 percent can be assumed to be new-to-transit. With no more specific data available, we assumed that each of these boardings was a substitute for an equal-distance auto trip. We then applied the recent Parry-Small (2009) estimates of auto externality costs. These authors estimated that peak-hour and off-peak externality costs (cents per passenger mile) for Washington, DC, were 25 cents and 6 cents, respectively. These were the sum of congestion costs plus pollution and accident costs less fuel taxes. The corresponding costs for Los Angeles were 31 cents and 8 cents, respectively. We did not have peak vs. off-peak trip diversion breakdowns and adopted 20 cents per automobile passenger-mile avoided as the average non-rider benefit.[2]

The results in the upper-right corner of Table 1 are not reassuring. We show the weighted averages of losses per passenger round-trip for the three types of rail transit studied in light of our effort to include non-user benefits. The weights are annual unlinked trips. On average, commuter rail costs society $42 per round-trip while heavy rail and light rail cost society $17 and $20 per boarding, respectively. (The ranges for this index, shown in Table A1b, are quite large.) In the lower left quadrant, we double the estimates of externality benefits, but the loss mitigations are small. The other two quadrants show results for a doubling of 2008 ridership and with the same two externality benefit assumptions. These assumptions cut the losses, but as we have emphasized at the beginning, such ridership levels are extremely unlikely in modern dispersed cities.

[2] Data in Table A2 are for vehicle-miles and we use passenger-mile cost estimates here. We could easily convert one to the other and get a slightly smaller non-user transit benefit estimate. But we are also missing the extra costs that the addition of rail imposes on bus operations costs when the number of transfers increases. Clearly, there are omissions on both sides of the ledger and we are left to assume that they roughly balance each other.

TABLE 1: NET LOSSES PER ROUND-TRIP BY RAIL TRANSIT TYPE:

Four Combinations of Assumptions

(weighted averages)

	Actual Ridership	Double Ridership
20 cents per mile auto externality	$42 CR $17 HR $20 LR	$15 CR $7 HR $9 LR
40 cents per mile auto externality	$39 CR $17 HR $19 LR	$13 CR $7 HR $8 LR

Transit-oriented development (TOD) advocates suggest that a radical re-organization of land uses can boost transit ridership.[3] Consider this statement by Filion and McSpurren (2007): "A supportive distribution of residential density is perceived to be an essential component of strategies aimed at increasing the use of public transit. To alter substantially land use-transport dynamics in a fashion that favours public transit patronage, residential density policies must be deployed over long periods and unfold at local and metropolitan levels simultaneously." (p. 501) But it is unclear how feasible or how costly it is to somehow reverse market forces. The latest available data for U.S. metropolitan areas shows that suburbanization trends continue.[4] This is

[3] "Smart Growth", "New Urbanist" and other similar platforms embrace the TOD idea.
[4] http://www.newgeography.com/content/001666-special-report-move-suburbs-and-beyond-continues

in spite of the fact that New Urbanist plans have been popular in much of this country for at least a quarter century.

CONCLUSIONS

It is well known that U.S. rail transit systems do not cover costs. Ridership is too low and/or costs are too high. The weighted average annual operating deficits in our sample were $21 million for the eight commuter rail systems, $329 for the six heavy rail systems and $48 million for the 20 light rail systems. Accounting for annualized capital costs makes these shortfalls much worse.

We have shown that accounting for non-user benefits does nothing to modify the assessment that introducing rail transit systems into modern cities cannot be justified on economic grounds. To be sure, any cost-benefit analysis leaves out various difficult-to-quantify intangibles. Rail transit advocates and various city boosters often mention how the “worldliness” or aura of their city would benefit from a world-class subway system. That is not our topic here, but we have shown that such intangibles face a huge hurdle if they are to overcome the large economic losses we have documented.

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TABLE A1a: Rail Transit Facilities Basic Data

METRO AREA	RAIL TYPE	NAME OF LINE	OPERATING AGENCY	YEAR OPENED	DIRECTIONAL ROUTE MILES	STATIONS	CAPITAL COST ($2009 M)	OPERATING COSTS ($2008 THOUS)	ANNUAL UNLINKED TRIPS (BOARDINGS)
Nashville, TN	CR	Music City Star Regional Rail	Music City Star Regional Rail	2006	62.8	6	43	4,057.90	166,750
Alexandria, VA	CR	Virginia Railway Express	Virginia Railway Express	1992	161.5	18	354	47,655.80	3,583,534
Fort Worth, TX	CR	Trinity Railway Express	Fort Worth Transportation Authority	1996	43.3	5	544	9,623.80	1,124,188
Baltimore, MD	CR	Maryland Area Rail Commuter	Maryland Transit Administration	1984	400.4	48	707	93,570.60	7,897,602
Salt Lake City, UT	CR	FrontRunner	Utah Transportation Authority	2008	87.7	8	758	16,567.90	1,429,633
Seattle, WA	CR	Sounder	Central Puget Sound Regional Transit Authority	2000	146.9	10	1,230	31,084.80	2,668,623
Los Angeles, CA	CR	Metrolink	Southern California Regional Rail Authority	1992	777.8	55	1,574	138,572.80	12,680,973
Dallas, TX	CR	Trinity Railway Express	Dallas Area Rapid Transit	1986	29	4	544	24,080.80	1,592,974
Miami, FL	HR	Metrorail	Miami-Dade Transit	1984	45	22	2,008	82,381.90	18,538,741
Baltimore, MD	HR	Metro Subway	Maryland Transit Administration	1984	29.4	14	2,706	54,980.70	13,894,282
Atlanta, GA	HR	MARTA	Metropolitan Atlanta Rapid Transportation Authority	1979	96.1	38	4,187	158,545.00	82,984,033
Los Angeles, CA	HR	Red Lines	LA County Metropolitan Transportation Authority	1993	31.9	16	7,801	95,929.50	43,584,566
Washington D.C.	HR	Metrorail	Washington Metropolitan Area Transit	1986	211.8	86	18,232	755,747.50	288,039,725
SF Bay Area, CA	HR	BART	Bay Area Rapid Transit	1972	209	43	13,279	478,986.90	115,227,684
Kenosha, WI	LR	Kenosha Historic Streetcars	Kenosha Transit	2000	1.9	2	2	279.90	65,759
Little Rock, AR	LR	River Rail	Central Arkansas Transportation Authority	2000	3.4	14	35	818.1	134,204
Memphis, TN	LR	MATA	Memphis Area Transit Authority	1993	10	7	129	3,920.80	1,014,777
Oceanside, CA	LR	Sprinter	North County Transit District	2008	44	15	315	7,219.80	717,960
Houston, TX	LR	METROrail	Metropolitan Transit Authority of Harris County	2004	14.8	16	434	15,858.50	11,800,912

Charlotte, NC	LR	Lynx Light Rail	Charlotte Area Transit System	2007	19	19	472	9,495.40	2,262,631
Minneapolis, MN	LR	Hiawatha Line	Metropolitan Transit	2004	24.4	17	701	23,697.50	10,221,681
Baltimore, MD	LR	Warren Road Light Rail	Maryland Transit Administration	1992	57.6	33	760	37,452.60	7,915,583
Sacramento, CA	LR	Sacramento RT Light Rail	Sacramento Regional Transit District	1987	73.8	48	1,084	51,829.50	15,484,670
Salt Lake City, UT	LR	TRAX	Utah Transportation Authority	1999	39.4	28	1,112	27,382.60	14,752,512
Buffalo, NY	LR	Metro Rail	Niagara Frontier Transportation Authority	1985	12.4	15	1,240	23,440.20	5,680,505
Philadelphia, PA	LR	River Line	Southeastern		82.4	45	1,288	59,509.00	29,497,103

METRO AREA	RAIL TYPE	NAME OF LINE	OPERATING AGENCY	YEAR OPENED	DIRECTIONAL ROUTE MILES	STATIONS	CAPITAL COST ($2009 M)	OPERATING COSTS ($2008 THOUS)	ANNUAL UNLINKED TRIPS (BOARDINGS)
			Pennsylvania Transportation Authority						
Newark, NJ	LR	Hudson-Bergen	New Jersey Transit	1983	12.4	17	1,394	18,762	6,196,905
Denver, CO	LR	D Line	Denver Regional Transportation District	1994	70	36	1,523	41,677.20	20,635,133
San Jose, CA	LR	VTA LRT	Santa Clara Valley Transportation Authority	1988	81	65	1,698	55,544.40	10,451,136
San Diego, CA	LR	San Diego Trolley	Metropolitan Transit System	1981	108.4	53	1,846	55,949.20	37,620,944
Seattle, WA	LR	Tacoma Link	Central Puget Sound Regional Transit Authority	2006	3.6	6	2,866	3,046.70	926,076
Portland, OR	LR	Metropolitan Area Express (MAX)	Tri-County Metropolitan District of Oregon	1978	52	84	2,970	84,120.10	38,931,646
Dallas, TX	LR	Red, Blue & Green Lines	Dallas Area Rapid Transit	1996-2009	87.7	34	3,560	89,218.00	19,437,603
Los Angeles, CA	LR	Green, Gold & Blue Lines	LA County Metropolitan Transportation Authority	1990	109.7	49	4,472	153,266.90	43,122,565

Table A1a notes: in $2009 unless otherwise stated

Sources:

Year	www.rtarelaxride.com, www.vre.org/about, www.the-t.com, www.mta.maryland.gov, www.rideuta.com, www.soundtransit.org, www.metrolinktrains.com, www.dart.org, www.miamidade.gov, www.itsmarta.com, www.metro.net, www.wmata.com, www.BART.gov, www.kenosha.org, www.cat.org, www.matatransit.com, www.ridetransit.org, www.sacrt.com, www.nfta.com, www.rtd-Denver.com, www.sdmts.com, www.trimet.org, O'Toole 2010
Miles	2008 NTD Data Tables: T23_Transit_Way_Mileage_Rail (reported in Directional Route Miles)
Stations	2008 NTD Database: Transit Station
Capital Cost	R. O'Toole, 2010
Operating Cost	2008 NTD Data Tables: T12_Op_Exp_Mode_function (reported in Total)
Annual Unlinked Trips	2008 NTD Data Tables: T26_Pass_Fare_Recovery_Ration (reported in Unlinked Passenger Trips)

TABLE A1b: Rail Transit Facilities Performance

METRO AREA	RAIL TYPE	ANNUAL NON-RIDER BENEFITS ($M)	ANNUAL NET REVENUES PLUS NON-RIDER BENEFITS (ANRPNRB; $M)	% NON-RIDER BENEFITS	ANRPNRB ($M)/MILE	***Σ/n ($M)***	ANRPNRB ($)/ UNLINKED TRIP	***UNWEIGHTED Σ/n ($)***	***WEIGHTED Σ/n***	PROP PAID BY RIDERS	***WTD Σ/n***
Nashville, TN	CR	0.202601	-6.55	1.8%	$0.10		$39.28			10.5%	
Alexandria, VA	CR	4.353994	-55.51	3.9%	$0.34		$15.49			23.1%	
Fort Worth, TX	CR	1.365888	-47.02	1.7%	$1.09		$41.82			10.2%	
Baltimore, MD	CR	9.595586	-105.05	4.3%	$0.26		$13.30			26.0%	
Salt Lake City, UT	CR	1.737004	-69.43	1.5%	$0.79		$48.56			8.9%	
Seattle, WA	CR	3.242377	-114.85	1.7%	$0.78		$43.04			9.9%	
Los Angeles, CA	CR	15.40738	-192.44	4.0%	$0.25		$15.18			23.7%	
Dallas, TX	CR	1.935463	-58.71	1.9%	$2.02		$36.86			11.3%	
						$0.71		$31.69	$20.86		21.2%
Miami, FL	HR	4.356604	-220.80	6.6%	$4.91		$11.91			9.4%	
Baltimore, MD	HR	3.265156	-255.57	4.4%	$8.69		$18.39			6.1%	
Atlanta, GA	HR	19.50125	-392.50	16.3%	$4.08		$4.73			26.0%	
Los Angeles, CA	HR	10.24237	-670.24	5.2%	$21.01		$15.38			7.4%	
Washington D.C.	HR	67.68934	-1,864.60	12.0%	$8.80		$6.47			18.2%	
SF Bay Area, CA	HR	27.07851	-1,403.85	6.5%	$6.72		$12.18			9.2%	
						$9.04		$11.51	$8.55		16.1%
Kenosha, WI	LR	0.015125	-0.37	13.9%	$0.20		$5.68			15.9%	
Little Rock, AR	LR	0.030867	-3.50	3.1%	$1.03		$26.08			3.2%	
Memphis, TN	LR	0.233399	-13.28	6.2%	$1.33		$13.08			6.5%	
Oceanside, CA	LR	0.165131	-31.84	1.8%	$0.72		$44.35			1.8%	
Houston, TX	LR	2.71421	-38.93	24.7%	$2.63		$3.30			32.4%	
Charlotte, NC	LR	0.520405	-45.21	4.1%	$2.38		$19.98			4.1%	
Minneapolis, MN	LR	2.350987	-69.82	11.8%	$2.86		$6.83			13.3%	
Baltimore, MD	LR	1.820584	-90.55	7.0%	$1.57		$11.44			7.4%	
Sacramento, CA	LR	3.561474	-123.38	10.0%	$1.67		$7.97			11.0%	
Salt Lake City, UT	LR	3.393078	-102.08	11.8%	$2.59		$6.92			13.2%	
Buffalo, NY	LR	1.306516	-117.55	3.9%	$9.48		$20.69			4.0%	
Philadelphia, PA	LR	6.784334	-133.44	17.8%	$1.62		$4.52			21.4%	
Newark, NJ	LR	1.425288	-124.80	4.1%	$10.06		$20.14			4.2%	
Denver, CO	LR	4.746081	-143.52	11.7%	$2.05		$6.96			13.1%	
San Jose, CA	LR	2.403761	-181.59	4.6%	$2.24		$17.38			4.8%	
San Diego, CA	LR	8.652817	-166.75	18.4%	$1.54		$4.43			22.2%	

Seattle, WA	LR	0.212997	-233.10	0.3%	$64.75		$251.71			0.3%	
Portland, OR	LR	8.954279	-284.02	11.1%	$5.46		$7.30			12.4%	
Dallas, TX	LR	4.470649	-356.14	4.4%	$4.06		$18.32			4.6%	
Los Angeles, CA	LR	9.91819	-469.59	7.3%	$4.28		$10.89			7.9%	
						$6.13		$25.40	$9.86		13.4%

Notes: Number of boardings are the weights for the weighted averages depicted in the far right columns. Proportion paid by riders equals ANRPNRB/AVG FARE ($)

TABLE A2: Average Trip Length and Average Fare Estimates

	U.S. Unlinked Trips (millions, 2007)	Ave Trip Length (2007)	Passenger Fare Collections ($M, 2007)	Fare/Boarding
Commuter Rail	459	24.3	$1,983.4	$4.32
Heavy Rail	3,460	4.7	$3,345.6	$0.97
Light Rail	419	4.6	$311.1	$0.74

Data from
http://www.apta.com/resources/statistics/Pages/transitstats.aspx
Appendix A
Tables 1,2, 42