Title

The Demographics of Public Transit Subsidies: A Case Study of Los Angeles

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THE DEMOGRAPHICS OF PUBLIC TRANSIT SUBSIDIES:

A CASE STUDY OF LOS ANGELES

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by

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ABSTRACT

Public transit subsidy represents a transfer of income from taxpayers to transit users. Such transfers raise questions regarding their effects, particularly equity. Our research focuses on social equity, and concerns the distribution of transit subsidies among socio-economic groups. Accordingly, this paper examines the ways that transit subsidy equity can be measured, and reviews the previous studies on this topic in detail. We propose a more precise method for measuring the subsidy of individual transit trips than has been employed in previous research. Using service consumption and travel survey data from the Los Angeles County MTA and a set of multi-factor cost allocation models developed in an earlier phase of this research, we examine the distribution of transit subsidies among various demographic groups.

We find that the distribution of transit costs and benefits among transit users is regressive with respect to income, more regressive than was found in most of the research conducted two or more decades ago. On average, consumers of short-distance local bus service — who are disproportionately low-income, African-American or Latino, younger, and female — require substantially less subsidy per trip than consumers of long-distance express or rail service — who are disproportionately higher-income, Anglo or Asian, older, and male. While low-income residents generally benefit from the public transit subsidy, this analysis finds that the benefits of subsidies disproportionately accrue to those least in need of public assistance. These findings raise questions regarding the conflicting objectives of transit policies which seek to deploy services to attract both transit dependents and choice riders.

Key words:

transit equity, transit subsidies, transit fares

1 OVERVIEW

Public transit is highly subsidized in the U.S. While taxis, airport shuttles, and the like are largely self-supporting, public transit trains, buses, and vans in the U.S. don't come close to covering their costs from fares and other income. In 1999, $21.5 billion in combined federal, state, and local funds were spent subsidizing public transit (American Public Transit Association, 1999a). Fares and other income cover just over half (58%) of all operating costs and only a fraction of all capital expenditures; the remainder of these costs are publicly subsidized (Federal Transit Administration, 1998). A 1988 study of transit subsidies in Europe and North America found that the taxpayer subsidy per transit trip in the U.S. was, by far, the highest of the dozen countries examined (Pucher, 1988). Since 1988, inflation-adjusted public subsidies per passenger trip on public transit have increased 18.3 percent from $2.07 to $2.45 in 1999[1]. While per capita transit use in the U.S. is lower than most other developed countries, the U.S. almost certainly spends more to subsidize each passenger trip than any other country in the world.

On what grounds do we justify this substantial and ongoing public subsidy of transit? A wide array of social objectives has been proffered. Some have argued that subsidized public transit systems help to decrease traffic congestion and reduce travel times for both users and non-users (Ferreri, 1979). Others suggest that the subsidy of public transit is justified, at least in part, by reducing auto use, energy consumption, and vehicle emissions (Ferreri, 1979). Other environmental benefits of transit have been offered as well: reduced suburban sprawl, a reduction of land devoted to roads, reductions in motor vehicle noise and accident costs, and so on (Ferreri, 1979). Some transportation economists have argued that the fundamental economic argument for

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1 Author's calculation from APTA data (APTA, 1999A).

public transit subsidies is that marginal cost pricing is insufficient to cover total costs because there are economies of scale/density in maintaining comprehensive transit route networks with sufficient service frequency (Vickrey, 1994; Small & Gomez-Ibanaz, 1999; Nash, 1988). Transportation analysts have also argued that public policy, especially in the U.S., does not adequately price the social costs of automobile use and, therefore, transit must also be underpriced, and subsidized, to attain an efficient allocation of traffic between automobile and transit modes (Jones, 1985).

A final set of arguments for the subsidy of public transit concerns equity. Public transit, from this perspective, is an indispensable social service that provides access to shelter, food, employment, health care, education, entertainment, and so on for people who, because of age, income, or disability, do not have regular access to private motor vehicles (Small & Gomez-Ibanez, 1999; Jones, 1985). As a critical social service, the subsidization of public transit can be viewed as the "redistribution of income to certain groups" in the form of transit service rather than money (Black, 1995).

While elected officials and transit managers tend to publicly focus less on the redistributive aspects of transit and more on its broader potential for transportation and environmental benefits, the redistributive role of U.S. public transit systems is indisputable. Table 1.1 shows that, with the exception of commuter rail passengers, transit patrons -- and especially transit bus patrons -- reside disproportionately in low-income households. Overall, one-third (33.0%) of all transit users come from households with 1995 incomes below $15,000, and three-fifths (59.0%) from households with 1995 incomes below $30,000 (Pucher, 1998).

Table 1. 1 Household Income Category for Travelers on Selected Modes for All Trips in 1995

MODE	MEDIAN HOUSEHOLD INCOME CATEGORY	MODAL HOUSEHOLD INCOME CATEGORY
Transit Bus	$15,000 - $19,999	$ 5,000 - $ 9,999
Urban Rail	$30,000 - $34,999	$15,000 - $19,999
Commuter Rail	$40,000 - $44,999	$55,000 - $59,999
Private Vehicle	$45,000 - $49,999	$35,000 - $39,999

Source: 1995 Nationwide Personal Transportation Survey.

The equity rationale for public transit has prompted numerous studies over the years which examine whether and to what extent the benefits of subsidized public transit are progressive with respect mainly to an array of social and demographic factors, particularly income. While these studies, most of which were conducted in the late 1970s and early 1980s (and which are detailed in the following section), pursued a wide array of analytical approaches, collectively their findings suggest:

1. Among transit users, the distribution of costs and benefits is regressive with respect to income. Higher-income transit users benefit more from the subsidy of transit than do low-income transit users.

2. Among the general population, however, transit subsidies generally result in a transfer of benefits from higher-income people to low-income people, though low-income non-transit-users are significant losers.

The first finding is surprising to many, and has attracted the most attention from transportation and public finance scholars. There are several reasons why higher-income transit users, on average, are subsidized at a higher rate than low-income transit users. In comparison with low-income transit patrons, higher-income transit users, in general,:

* travel longer distances and thus pay lower fares per mile of travel;

* are more likely to use transit for commuting at peak hours and in peak directions when service supply costs are higher, and
* are more likely to patronize capital- and resource-intensive modes, like commuter rail and express service on busways.

In spite of the disproportionate use of public transit by low-income people (or perhaps because of it), transit systems around the U.S. have devoted substantial resources in recent years to building and operating commuter-oriented bus and rail services in an attempt to attract more automobile users (termed "choice riders") to their systems. In particular, federal transit subsidy policy strongly favors the development of capital intensive transit services over the operation of existing transit services (Garrett & Taylor, 1999). Between 1983 and 1994, total revenue vehicle miles of bus service nationwide increased 10.7 percent; during this same period subway and elevated rail transit service increased 28.8 percent, commuter rail service increased 31.6 percent, and light rail (streetcar) service increased 108.1 percent (Price Waterhouse LLP, 1997). In 1993, buses carried over twice as many passengers (5.4 billion) as all rail transit modes combined (2.6 billion) (APTA, 1998), but total expenditures on bus and rail transit (most of which came from government subsidies) were approximately equal ($10.1 billion) (Price Waterhouse LLP, 1997).

The often conflicting goals of serving low-income transit dependents on one hand, and expanding commuter-oriented services on the other have strained transit systems and have prompted criticism from some advocates for the poor. Since both the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Transportation Equity Act for the 21st Century (TEA 21) mandated that the expenditure of federal funds for transportation purposes must comply with Title VI of the Civil Rights Act,[2] civil rights lawsuits have been brought against several major U.S. regional transit operators in recent years claiming that fare policies and/or efforts to expand suburb-to-downtown commuter transit services are discriminatory.[3]

Given current legal and policy debates over the equity of public transit subsidies and service provision, this paper examines the demographic distribution of public transit subsidies. We begin by reviewing past studies on transit equity to identify the methods used, the conclusions drawn, and the shortcomings of this now largely dated research. Building on the previous research, we then propose a more sophisticated and precise method for measuring the level of subsidy for individual transit trips. Using data from the Los Angeles County Metropolitan Transportation Authority (MTA), we then analyze the distribution of transit subsidies among various demographic groups. In a nutshell, we find that the distribution of transit costs and benefits is regressive with respect to income, more regressive than was found in most of the research on this question conducted two or more decades ago. In addition, we find that Anglo and Asian transit riders in Los Angeles, on average, are subsidized at higher levels than African-Americans, Latinos, or Native Americans. Correspondingly, older passengers and men receive higher per rider subsidies, on average, than do younger passengers or women.

2 MEASURING AND EVALUATING THE SUBSIDY OF TRANSIT PASSENGERS

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2 Title VI of the Civil Rights Act of 1964, 42 U.S.C. section 2000(d) prohibits federal funds to be used by recipients and result in discrimination on the bases of race, color, or national origin.

3 See Committee for a Better North Philadelphia v. Southeastern Pennsylvania Transportation Authority (SEPTA), 1990 U.S. Dist. Lexis 10895 (E.D. Pa 1990), *aff'd*, 935 F.2d 1280 (3rd Cir. 1991); New York Urban League, Inc. v. Metropolitan Transportation Authority, et al., 95 Civ. 9001 (RPP); *reversed* New York Urban League, Inc. v. The State of New York, Metropolitan Transportation Authority, et al., 71 F.3d 1031 (2nd Cir. 1995); Labor/Community Strategy Center, et al., v. Los Angeles Metropolitan Transportation Authority, et al., Case No. CV 94-5936 TJH.

Measuring how per-passenger subsidies vary among different demographic user groups requires a clear understanding of both ridership demographics and transit service costs. Put simply, transit subsidies cover the deficit between expenditures on one hand, and fares and other income on the other. We can measure the level of subsidy for the transit industry as a whole, the subsidy of an individual transit operator, the subsidy of individuals or classes of individuals, or the subsidy of an individual trip.[4] For an individual trip, the subsidy is the difference between the cost of carrying a passenger and the fare paid by that passenger. Since the cost of providing transit service can vary significantly from system to system and from trip to trip, transit subsidies can vary significantly as well. The cost of transit service has been shown to vary by mode, service type (e.g. local versus express lines), by time of day and day of the week, and by direction. In general, the unit costs of capital intensive transit modes (busways, rail transit, etc.) and peak (time and direction) service are higher than non-capital intensive modes and off-peak service (Taylor, Garrett, & Iseki, 2000).

While determining total transit industry subsidies is quite straightforward, measuring the subsidy of an individual trip is more complicated for three reasons. First, system costs must be broken down and allocated to service outputs. Second, the cost of a unit of transit service must then be divided among all of the customers of that unit of service. And third, the fare paid by the individual must be deducted from the individual trip cost to determine the individual subsidy.

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4 This research examines only *internal* costs and subsidies. A complete full-cost accounting of the transportation system should consider both internal costs of travel and the external costs -- like delay imposed on others and vehicle emissions -- as well. Such full social cost accounting is especially important for evaluating the relative costs and benefits of various transportation modes (Greene, Jones, &Delucchi, 1997). While we would agree that a precise full social cost accounting is a desirable objective, we would argue that an important first step in such an accounting is a complete and accurate measurement of internal transit costs (Taylor, Garrett, & Iseki, 2000).

Thus individual and group subsidies highly depend on both the amount of transit service consumed and the utilization of that consumed service by others (Hodge, 1988).

Our focus here is on *social equity*, and our research question concerns the distribution of transit subsidies among socio-economic groups.[5] Altshuler, Pucher, and Womack (1979) and Rosenbloom and Altshuler (1979) identify three ways that social equity is typically defined in transportation policy: (1) fee for service, (2) equality in service distribution, and (3) distribution according to need. The first principle derives from private markets, in which the quality of goods and services varies in proportion to the price, fare, and fee paid. Under the second principle, each individual is entitled to an equal share of public expenditures or public services (both quantity and quality) regardless of need or financial contribution. And under the third principle, each individual is entitled to receive a share of public expenditure or service in accordance with individual need. From an ideological perspective, political conservatives are most likely to favor the *fee for service* principal, moderates the *equality of distribution* principle, and liberals the *distribution according to need* principle. In this research, we use the second, equality of distribution principle to guide our analysis, not for normative reasons, but because distributional equity measures are useful in analyzing equity from each of these three perspectives.

3 PREVIOUS RESEARCH ON TRANSIT SUBSIDY EQUITY

Table 3.1 synthesizes the approaches taken to measuring and evaluating transit subsidy equity in 15 previous studies. We have organized these studies into six groups, based on similarity of approach, which we discuss in turn below.

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5 Most public debates over transit finance, however, concern *geographic equity*, or how transit subsidies are distributed among jurisdictions and transit operators (Taylor, 1995; Lem, 1997). In addition, some scholars argue that distribtuional impacts are over-emphasized planning practice, and that the equity of planning processes and public involvement in decision-making should be considered as well (Young, 1998).

Table 3.1 Synthesis of the Approaches in Transit Subsidy Equity Evaluation Studies

			Group 1	Group 2					
			Webber (1975)	Leutze & Ugolik (1977)	Rock & Zavattero (1979)	Bates & Anderson (1982)	Pucher, Hendrickson, & McNeil (1981)	Pucher & Williums (1992)	Pucher, Evans, and Wenger (1995)
(1) Costs									
	1.1 Level of Aggregation	Industrywide							
		by System							
		by route segment							
		by Trip							
	1.2 by Cost Category	Operating							
		Capital							
	1.3 by Service Type	Mode							
		Service Type (local, express)							
		by Line							
		Time of day							
		Direction (inbound, outbound)							
(2) Revenues									
	2.1 Fares/Income	Industrywide							
		by System		O					
		by Mode							
		by Route Segment							
		by Demographic Group							
		by Trip		O					
	2.2 Subsidies (i.e. costs- income)	Industrywide							
		by System	O						
		by Mode							
		Time of day							
		by Trip							
	2.2 *by Cost Type*	Operating	O						
		Capital	O						
	2.2 *by Tax Source*	Federal							
		State							
		Local	O						
	2.2 *by Tax Type*	Tax Instrument	O						
	2.2 *Taxpayer Demographics*	by Income Categroy	O						
(3) Travel Behavior									
	3.1 Demographics	Income	O		O	O	O	O	O
		Ethnicity			O	O	O	O	O
		Sex		O			O	O	O
		Age		O			O	O	O
		Auto-access		O					
		Drivers' licensing		O					
	3.2 Trip Characteristics	Distance		O	O	O	O	O	O
		by Straightline Estimate		O	O	O			
		by Estimated Route Distance							
		Time of day		O			O	O	O
		Direction							
		Mode			O	O	O	O	O
		Purpose		O					
		Location		O			O	O	O
		Vehicle Utilization (crowding)							
Unit of Anlaysis			Income group	Average fare per trip mile	Average trip distance	Average trrp distance	Passenger trip	Passenger trip	Passenger trip

Table 3.1 (Continued)

		Group 3			Group 4		Group 5	Group 6	
		Altshuler, Pucher, and Womack (1979)	Pucher (1981)	Pucher (1982)	CRA Inc. (1986)	CRA Inc. (1989)	Cervero (1981A), Cervero (1981B)	Hodge (1988)	This study
(1) Costs									
1.1 Level of Aggregation	Industrywide				O	O			
	by System						O	O	O
	by route segment							O	
	by Trip						O	O	O
1.2 by Cost Category	Operating				O	O	O	O	O
	Capital						O		O
1.3 by Service Type	Mode				O	O			O
	Service Type (local, express)						O	O	O
	by Line						O	O	O
	Time of day				O	O	O		O
	Direction (inbound, outbound)								
(2) Revenues									
2.1 Fares/Income	Industrywide				O	O			
	by System				O	O	O	O	O
	by Mode				O	O			O
	by Route Segment							O	
	by Demographic Group						O	O	O
	by Trip						O		O
2.2	Industrywide	O	O	O	O	O			
Subsidies (i.e. costs- income)	by System			O			O	O	O
	by Mode	O	O	O	O	O			
	Time of day				O	O			
	by Trip								
2.2 *by Cost Type*	Operating	O	O	O	O	O			
	Capital	O	O	O					
2.2 *by Tax Source*	Federal	O	O	O	O	O			
	State	O	O	O				O	
	Local	O	O	O				O	
2.2 *by Tax Type*	Tax Instrument	O	O	O				O	
2.2 *Taxpayer Demographics*	by Income Categroy	O	O	O	O	O		O	
(3) Travel Behavior									
3.1 Demographics	Income	O	O	O	O	O	O	O	O
	Ethnicity						O		O
	Sex						O		O
	Age						O	O	O
	Auto-access						O	O	
	Drivers' licensing								
3.2 Trip Characteristics	Distance				O	O	O	O	O
	by Straightline Estimate								
	by Estimated Route Distance							O	O
	Time of day						O		O
	Direction								
	Mode	O	O	O	O	O			O
	Purpose						O		
	Location							O	
	Vehicle Utilization (crowding)				O	O	O	O	O
Unit of Anlaysis		Passenger trip	Passenger trip	Passenger trip	Passenger trip	Passenger trip and passenger mile	Passenger trip	Passenger trip	Passenger trip

Group 1: Webber's eyeball analysis of tax incidence and ridership by income level

In his 1975 report on the then new Bay Area Rapid Transit system (BART), Webber (1976) draws on Hoachlander's (1976) analysis of the incidence of property and sales taxes used to pay for most of the new BART system and the incomes of BART district residents. Webber argues that BART taxes disproportionately burden low-income households, while BART service is disproportionately utilized by higher-income households. While Webber's early study presents a convincing *prima facie* case for regressive income transfers in the case of BART, he does not measure how costs, fares, or subsidies vary from rider to rider, or income group to income group.

Group 2: Studies which link detailed demographic data with basic service consumption data to evaluate the distribtuional effects of transit service and fares.

The second group of studies uses demographic data on transit users from either transit system rider surveys or the Nationwide Personal Transportation Survey (NPTS) in combination with travel distance data, fare data , or descriptive findings regarding transit costs to draw conclusions regarding transit service equity (Leutze & Ugolik, 1978; Rock & Zavattero, 1979; Bates & Anderson, 1982; Pucher, Hendrickson, & McNeil, 1981; Pucher & Williams, 1992; Pucher, Evans, & Wenger, 1998).

The two studies by Rock and Zavattero (1979) and Bates and Anderson (1982) calculated average trip distance by income and ethnic groups, and examined the equity of flat fare policies. Rock and Zavattero found the flat fare policies are regressive with respect to income, but neutral with respect to ethnicity. And despite Bates and Anderson's claims to the contrary, the data presented in their paper are consistent with the findings of Rock and Zavattero. Three studies conducted by Pucher and various colleagues (Pucher, Hendrickson, & McNeil, 1981; Pucher & Williams, 1992; Pucher, Evans, & Wenger, 1998) analyzed the NPTS travel behavior data in detail and combined these with descriptive conclusions regarding the variability of transit costs to draw conclusions regarding transit service equity. These studies consistently found that, on average, the poor, non-whites, women, bus patrons, off-peak travelers, and short-distance travelers received lower per-ride subsidies than their counterparts.

Leutze and Ugolik (1978) combined disaggregated fare information with individual travel behavior data, including travel distance, for the Albany, New York transit system using the passenger fare paid per mile as a unit of analysis.[6] With the exception of Leutze and Ugolik, studies in this second group generally do not analyze any data on transit system costs and/or revenues. Even where the authors assume that all riders pay the same fare, the estimates of per trip subsidies are not directly linked to estimates of transit costs. This potentially introduces bias into the analysis and makes it impossible to conduct multi-variate causal analyses of the interplay of various service supply and consumption factors in explaining subsidy variability.

Group 3: Pucher's studies to analyze both "who benefits from" and "who pays for" public transit service

Drawing on the tax incidence literature in public finance that examines who pays taxes and who benefits from their expenditure, the third group of transit subsidy distribution studies attempts to link transit tax payments with transit patronage benefits (Altshuler, Pucher, & Womack, 1979; Pucher, 1981, 1982). By combining 1970 or 1977-78 NPTS data and federal, state, and local transit tax incidence data, these studies found the distribution of costs (taxes paid) and benefits (transit service consumed) was progressive with respect to income.

Assuming all trips on each mode are subsidized equally (which is clearly not the case),

6 Travel distance is estimated using a straight line between an origin and a destination of individual trips.

Altshuler, Pucher, and Womack (1979) combined modal patterns of transit use by income groups with the distribution of operating and capital subsidies among modes, and found that the lowest-income groups actually received lower than average transit *operating* and *capital* subsidies per household. However, taking into account the tax burden for transit subsidies by each income class, they found the net income per household was mostly progressive mainly because the overall tax system is progressive. Pucher (1981) also found that per passenger operating subsidies in 1978 were significantly higher for commuter rail ($1.53) and slightly higher for rapid rail ($0.41) in comparison with bus transit ($0.37), and that the distribution of subsidies among income classes mirrored the distribution of income among all urban households.

By including capital subsidies in estimating costs and by considering the income distribution of transit taxpayers, the three studies in this third group contributed significantly to our understanding of the distribution of costs and benefits of transit subsidies. These studies, however, have some shortcomings. First, while the travel behavior data in these three studies were disaggregated to the person trip level, the estimates of transit subsidies are based on aggregated data which significantly diminished the precision of the subsidy estimates. Secondly, the analysis did not account for cost variation in service provision within modes, as Pucher (1981) acknowledges.[7] Third, while these studies concluded the distribution of transit costs and benefits was progressive with respect to income, one might reasonably compare the distribution of service benefits with the distribution of income among transit users, rather than the entire urban population. Since transit is patronized disproportionately by low-income people, the same data analyzed on a per passenger basis may suggest that distribution of subsidy among transit

7 *i.e.* trip distance, time of travel, direction of trave, and so on.

riders may be regressive with respect to income. And finally, in the two decades since Pucher's studies, the public subsidy of transit has shifted significantly from the federal government to states and localities (Price Waterhouse LLP 1997). Since the collection of federal taxes tends to be more progressive with respect to income than state and local taxes used to subsidize transit, the income progressivity of transit subsidies observed by these three studies may have diminished over time.[8]

Group 4: CRA industrywide studies applying cost allocation models to estimate fare payments, federal operating subsidies, and levels of crowding.

Charles River Associates Incorporated (CRA 1986, CRA 1989) developed a cost allocation model[9] to compute the average cost per passenger trip by transit mode (bus, subway, commuter rail, and light rail), by time of day, and by trip distance. They then computed the average federal operating subsidy per trip for different income groups, accounting for the average fare paid for each mode, federal operating subsidies, and the number of trips made in each mode by income group. The CRA cost allocation model included a passenger-mile factor to account for the smaller fraction of costs allocated to each passenger trip in the peak period due to the level of crowding and associated reduction in service. These studies concluded that the average federal operating subsidy per trip increased with income. Average federal operating subsidy per trip in 1983 was $0.122 for households with incomes with less than $10,000, $0.173 for households with incomes between $20,000-29,999, and $0.202 for households with incomes above $50,000. Although these studies attempted to account for a wide variety of factors thought

8 Pucher (1982) found that the state and local transit taxes in most of the nine urban areas studied were regressive with respect to income.

9 The cost allocation model included three variables -- vehicle hours, passenger miles, and passenger trips -- and accounted for labor utilization as well.

to influence transit costs, their application to aggregated national data prevents accounting for cost variation at the system, mode, line, or run level. In addition, these two studies did not include capital subsidies and did not examine demographic factors other than incomes.

Group 5: Cervero's cost allocation model to estimate the costs to provide transit service, fare paid by individual transit riders, detailed travel behavior analysis, and levels of crowding.

Cervero's studies (1981A, 1981B) used cost allocation models to more accurately account for the cost variation in transit service provision than in any previous study. He developed detailed cost allocation models for three California transit operators -- the Southern California Rapid Transit District, the Alameda-Contra Coast Transit Authority, and the San Diego Transit Corporation -- which accounted for the cost variation by time of day, by trip distance, and by the level of crowding and included both operating and capital depreciation expenses to compute cost per passenger mile (CPM). Revenue per passenger mile (RPM) was also estimated for individual trips to obtain the ratio of RPM to CPM for more than 10,000 travel survey cases. Finally, this ratio (RPM/CPM) was aggregated by trip characteristics and by socio-demographic characteristics of transit users.

Cervero found that the distributional effects of transit pricing appeared to be only modestly regressive in terms of socio-demographic characteristics – lower income, transit-dependent, and minority users tended to return a higher share of their costs than the average passenger, and he found that there was significant variation in RPM/CPM by travel distance and by time of day. Cervero also found that the difference in subsidy can generally be attributed more to trip characteristics, especially as a function of trip distance, than to socio-demographic characteristics of transit users.

Group 6: Hodge's spatial analysis study using (1) a cost allocation model to estimate costs, fares, and subsidies, (2) information on the level of crowding and transfers, and (3) transit incidence data.

Hodge (1988) examined the geographic distribution of transit subsidies in King County, WA, taking into account the following factors: (1) variation in cost by the level of ridership for route segments, (2) allocation of fare paid by riders to lines, and (3) residential location of transit users as well as their socio-economic characteristics. Hodge developed a two-variable cost allocation model to estimate the cost to provide service for each bus route segment, and divided these costs by the number of passengers on-board in each segment to obtain the *cost per passenger* for each bus route segment. By doing so, he took into account the variation in transit operating subsidy by the level of crowding that significantly varies by location[10] as well as by line. Taking the difference between the cost and the fare for each route segment,[11] the subsidy per segment was computed, and the total subsidy per passenger was measured by tracing the rider's route and summing up together the subsidy consumed over every segment traveled.

Hodge's analysis of subsidies by socio-economic characteristics revealed that, compared to the system average subsidy of $0.577: (1) users with no cars, $0.599, (2) users from one person household, $0.475, (3) users of 65 years or older, $0.621, and (4) users with household income less than $6,000, $0.620. All of these user groups also averaged shorter travel distances

10 First, the level of travel demand varies due to the geographic distribution of residential and employment locations of transit users. Second, since trip origins and destinations are not evenly distributed in space, more people are on board while a bus approaches to a stop where many people have their destinations. (Hodge, 1988). For example, assuming that people live in suburbs, work in downtown, and commute by bus, the more and more riders get on a bus as a bus travels from suburbs to downtown in the morning peak. On the other hand, in the afternoon peak, a bus leaves with many riders in downtown, and drops off passengers as it approaches to suburbs.

11 The allocated fare for a bus route segment was the sum of fare paid by each passenger to each segment in proportion to the relative cost per passenger for each segment.

and had residential locations closer to the CBD than their counterparts. Hodge's innovative research also examined the geographic distribution of user cross-subsidies and net subsidies by accounting for the collection and distribution of tax revenues by income level, and the income level composition of households in census tracts. The geographic distribution of subsidies showed that residents in outlying areas cross-subsidized transit users in the inner-city. While Hodge took into account taxes to finance transit service and added a geographic component in the analysis, his cost allocation model was relatively primitive, with only two variables, and did not take into account the cost variation by time of day, by mode, or by direction.

In sum, among transit users, the distribution of transit subsidies has consistently been found to be income regressive due to systematic variation in travel patterns by income. This review of transit subsidy equity research reveals the importance of accounting for: (1) the variation in transit service supply costs by mode, by line, by time of day, and by peak direction, (2) the variation in subsidies by trip distance and by the level of crowding, (3) the inclusion of both operating and capital subsidies, (4) the need to utilize smaller, more disaggregated units of analysis, such as a passenger trips, and (5) the collection and distribution of taxes to finance transit subsidies. A comprehensive analysis of the incidence of transit taxes requires one to obtain extensive information on federal, state, and local taxes by demographic category. Our analysis of transit subsidy equity both updates the increasingly dated body of literature on this topic, and accounts for all but the fifth factor listed above; and it is to this analysis that we now turn.

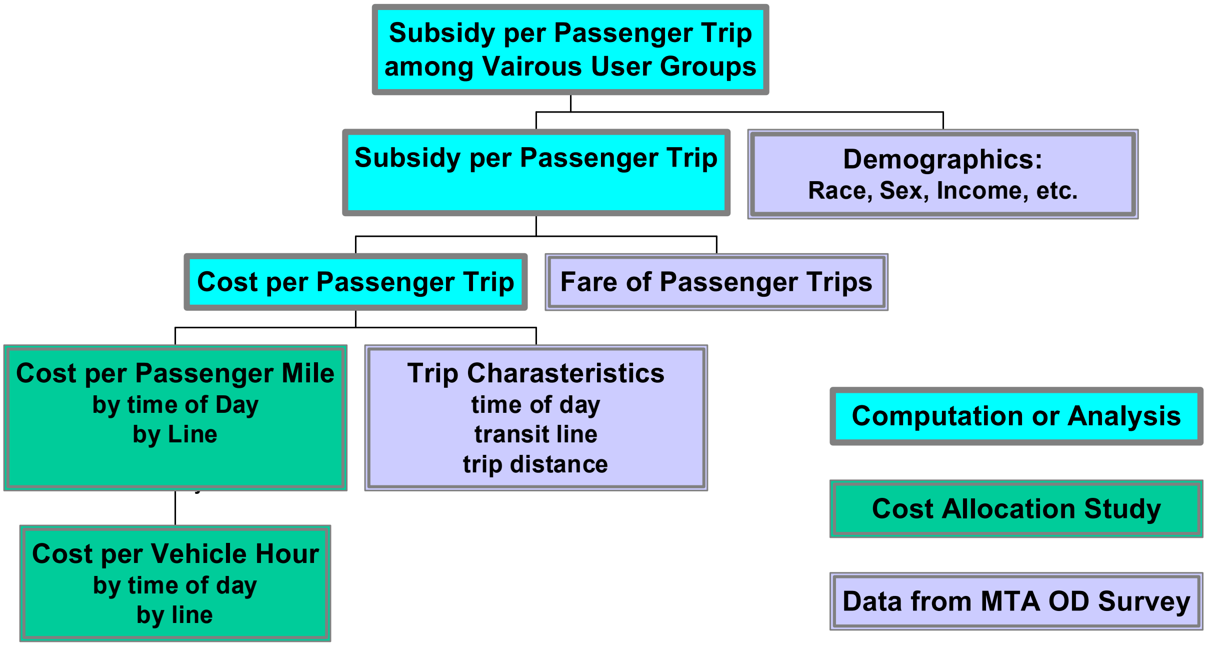
4 DATA AND METHODOLOGY

The cost and ridership data analyzed in this research are for the Los Angeles County

Metropolitan Transportation Authority (LA MTA). Contrary to its reputation as the sprawling car and freeway capital of the world, Los Angeles is a densely developed urban area with relatively high levels of transit ridership. In fact, the Los Angeles Urbanized Area (UZA) has a substantially higher population density (5,525 persons per square mile) than even the New York UZA (4,123 persons per square mile) (U.S. Census Bureau, 1999). The largest transit operator in the region, the LA MTA, carried 398,630,100 unlinked passenger trips in 1999, making it the third largest transit system in the U.S. (behind New York and Chicago) and the nation's second largest bus operator (behind only New York) (American Public Transportation Association, 1999B). In 1998, the LA MTA fleet consisted of 2,566 vehicles operating in four modes: 2,301 buses, 166 demand response vehicles, 69 light rail cars, and 30 heavy/rapid rail cars (National Transit Database, 1998). While the vast majority (89.7%) of the LA MTA fleet is buses which carry the vast majority of its riders (90.9%) (National Transit Database, 1998), the bulk of both public attention and capital expenditures in recent years has focused on the development of the agency's system of light and heavy rail lines.

Passenger fares and other operating income covered one-third (33.0 %) of the LA MTA's 1998 operating expenses of $724,307,728 and none (0.0 %) of its $149,433,096 in capital expenses (National Transit Database, 1998). Like most large urban transit agencies, the LA MTA draws public subsidies from a variety of sources to make-up the shortfall between income and expenses. In 1998, the federal government supplied more than one-fifth (21.8 %) of the LA MTA's subsidies; Only a fraction (1.8 %) came from the State of California, while over three-quarters (76.6 %) came from local sources (NTD, 1998), primarily sales taxes. The steps followed in allocating these subsidies to individual passenger trips are summarized in Figure 4.1.

Figure 4.1 Analytical Flowchart to Estimate Subsidy per Passenger Trip among User Groups



Our first step was to estimate the cost of in-service vehicle hours using a comprehensive, multi-factor cost allocation model developed in an earlier stage of this research (Taylor, Garrett, & Iseki, 2000). The model accounts for both operating and annualized capital costs and produces separate cost estimates for two modes (bus and light rail),[12] for each line on each mode, and for three daily time periods[13] for each line on each mode. Second, we obtained in-service vehicle hour data and passenger-mile data for each line in each time period from the LA MTA *Ridecheck Database* for 1996-97. Costs per passenger-mile for each line on both bus and light rail modes in each time period were computed by multiplying cost per vehicle-hour by the ratio of passenger-

12 Heavy/rapid rail transit service was not yet in operation at the time that the LA MTA On-Board Passenger Origin-Destination Survey data (discussed below) were collected.

13 The three time periods we used were: Base (9 pm to 6 am), Midday (9 am to 3 pm and 6 pm to 9 pm), and Peak (6 am to 9 am and 3 pm to 6 pm).

miles to vehicle-hours in each period.[14] Converting costs per in-service vehicle hour into costs per passenger-mile takes the level of crowding into account, which is one measure of the quality of service provided.

Third, we obtained data on individual trips (mode(s), route(s), time-of-day, direction, fare type, and fare paid[15]) and the demographics of the passengers making these trips (age, sex, ethnicity, income, etc.) from the LA MTA On-Board Passenger Origin-Destination Survey for the fiscal years 1991-93.[16] The LA MTA survey data also provide addresses for (1) the origin of the trip, (2) the nearest transit stop to the trip origin, (3) the nearest transit stop to the destination of the trip, and (4) the destination of the trip. We geocoded the addresses (i.e. assigned latitude and longitude coordinates for each address) and computed the distance of each trip by measuring the shortest path along the LA MTA transit route network between the origin and destination using the Network Analyst functions in ESRI's *ArcView*. While this method may incorrectly estimate trip distance for passengers who traveled by something other than the shortest path in their journey, it is far more accurate than straight-line estimates of trip distance used in several of

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14 We choose this method of computing costs per passenger-mile because the data for our analysis were drawn from different time periods. Therefore, instead of computing costs per passenger mile by simply dividing the total costs by passenger-miles for each line in each time period, we assumed that the ratio of passenger-miles to in-service vehicle-hours did not significantly change over the period under study. We believe that this assumption is reasonable for two reasons; One, we observed little change in ridership per in-service vehicle hour by line between two time periods. Two, the average trip distance is unlikely to significantly change over a span of just four years.

15 The fare types and levies during the study period (fiscal years 1991-1993) were: (1) base, cash fare ($1.10), (2) discount ticket fare ($0.90), (3) elderly/disabled fare ($0.50), (3) student fare ($0.50), (4) estimated average fare from unlimited ride pass users (which varied based on an unpublished algorithm developed by LA MTA staff), (5) transfer fares ($0.25), and (6) express surcharges ($0.40 per zone). Between June and October of 1992, a discount ticket fare of $0.50 was in effect in response to the civil unrest and riots in April of that year. The fare payment used in our analysis is the fare payment reported by the survey respondent.

16 The latest year for which we were able to obtain such data.

the earlier studies cited above (Leutze & Ugolik, 1978; Rock & Zavattero 1979, Bates & Anderson 1982). Because many of the records in the MTA On-Board Passenger Origin-Destination Survey data set were missing at least some of the data required for this analysis and, in some case, there were inadequate data to estimate costs for lightly patronized lines during some time periods, costs and subsidies were estimated for a total of 11,986 trips (10,895 via bus and 1,091 on light rail).[17]

Combining the data from these three sources enabled us to estimate the fully-allocated cost of each of the 11,986 geocoded passenger trips by multiplying the estimated cost per passenger-mile for the time period in which the trip was made by the distance of the trip. The subsidy for each trip was then computed by simply subtracting the fare paid from the estimated cost of each passenger trip.[18] These steps are summarized in the equation (1) below.

$$\begin{aligned} &\text{Subsidy per passenger trip} \\ &= \text{Cost per passenger trip} - \text{fare} \qquad (1) \\ &= \left(\text{Cost per vehicle hour} \times \frac{\text{vehicle hour}}{\text{passenger miles}} \times \text{travel distance}\right) - \text{fare} \end{aligned}$$

While computationally complex, this analysis produces far more precise estimates of passenger trip costs and subsidies than most of the previous research on this topic, and slightly more precise estimates than those produced by Cervero (1981A, 1981B). While a substantial

17 The original LA MTA Origin-Destination data set contains 16,016 records. We compared our final data set with this original data set with respect to both trips and demographics and found no systematic bias in the trips excluded.

18 We have not yet been able to obtain sufficient information from the LA MTA to allow us to weight this sample up to estimate the costs, fares, and subsidies for all trips made on LA MTA buses and trains. We thus report only unweighted results here which, lacking information to the contrary, we assume to be a random and representative sample of LA MTA passengers.

methodological improvement over previous research on this topic, this analysis, too, has some shortcomings. First, neither this analysis nor any of the previous research on this topic accounts for directional peaking of service and demand. Directional peaking on transit can be substantial and should be accounted for in the allocation of costs. Second, unlike the earlier studies by Altshuler, Pucher, and Womack (1979), Webber (1976), Pucher (1981, 1982), and Hodge (1988), this research does not consider the incidence of taxes used to subsidize transit. We chose not to include tax incidence data in the analysis because the findings from previous research are remarkably consistent (i.e. transit riders, especially low-income riders, are the biggest winners, and non-riders, especially low-income non-riders, are the biggest losers) and we do not anticipate our results for Los Angeles would deviate from these earlier findings. In our view, the principal weakness of the previous research is the outright absence or over-aggregation of cost data, and we focused our efforts on this issue. Third, more detailed information on the origins, destinations, and transfers of passenger trips would permit slightly more precise estimates of trip distances than those produced here. Finally, data limitations did not allow us to proportionally allocate the fares paid to each of the individual links on a trip (particularly for trips on multiple lines and/or modes); more complete data would allow us to do so.

5 Overview of LA MTA Passenger Demographics

Nationwide, the patrons of public transit are more likely than the general population to be low-income, non-white, young or old, and female (American Public Transit Association, 1992; Pucher, Evans, & Wenger, 1998; Pisarski, 1996). In comparison to transit passenger demographics nationwide, patrons on LA MTA buses and trains are even poorer and less likely to be white.

Table 5.1 summarizes the demographics of LA MTA bus passengers during the 1996-97 fiscal year. First, and perhaps most significantly, LA MTA bus riders are poor. Two in five bus riders (40.2%) report that they reside in *very* low-income households (below $7,500 per year), and over two-thirds (69.2%) of all LA MTA bus riders come from households with 1995 incomes below $15,000. By way of comparison (though not accounting for the effects of relatively low inflation rates during the 1990s), only 20.3 percent of the Los Angeles County population resided in households with 1990 incomes below $15,000 (U.S. Census Bureau, 1999). Nine in ten (89.8%) LA MTA bus riders live in households with 1995 incomes below $35,000, while only a fraction (4.3%) of LA MTA bus riders come from households with 1995 incomes above $50,000, and just one in sixty-seven riders (1.5%) reported 1995 household incomes above $75,000. In contrast, about a third (32.7%) of all Los Angeles County residents lived in households with 1990 incomes above $50,000 (U.S. Census Bureau, 1999).

Not only are most LA MTA bus riders poor, they are almost entirely non-Anglo. The majority (52.1%) of LA MTA bus riders are Hispanic. While the 1990 Los Angeles County population was less than 10 percent African-American, more than two-fifths (22.1%) of LA MTA bus riders are black. Collectively, Asian-Pacific Islanders, Native Americans, and those reporting their race/ethnicity as "other" outnumber non-Hispanic whites on LA MTA buses, 13.2 percent to 12.5 percent.

In comparison to transit riders nationally, LA MTA bus riders tend to be relatively young. Nearly two-thirds (62.3%) of all LA MTA bus riders are younger working-age adults (ages 18 to 44), while just over two-fifths (21.8%) are older working-age adults. While similar to national patterns, the use of LA MTA buses by younger adults is more pronounced in Los Angeles largely because it has been the most common city of entry for immigrants to the U.S. during the 1980s and 1990s. Meyers (1998) reports that recent (primarily Hispanic and secondarily Asian-Pacific Islander) immigrants to the Los Angeles region make up only 13 percent of all workers, but comprise 42 percent of all transit commuters (Meyers, 1998).

Finally, the use of LA MTA buses by women (55.2%) and men (44.8%) almost exactly matches the use of transit by women (55.6%) and men (44.4%) nationwide (Nationwide Personal Transportation Survey, 1995).

Table 5.1 MTA Bus Rider Demographics

1995 Household Income	< $7.5k	$ 7.5-15k	$ 15k-35k	$ 35-50k	$ 50-75k	> $ 75
	40.2%	29.0%	20.6%	6.0%	2.8%	1.5%

Race/Ethnicity	Native	Asian/PI	Black	Hispanic	White	Other
	1.1%	8.7%	22.1%	52.1%	12.5%	3.4%

Age	Under 18	18 - 24	25 - 44	45 - 64	Over 65
	7.6%	18.0%	44.3%	21.8%	8.3%

Sex	Female	Male
	55.2%	44.8%

Data source: Service Planning Market Research Program, "FY96-97 MTA Bus On-Board Passenger Survey."

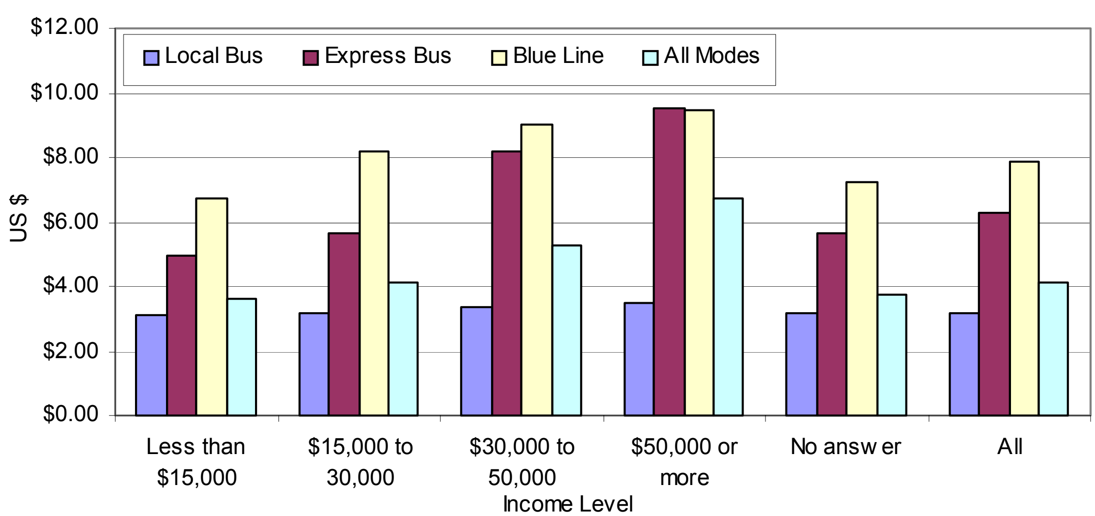
6 Analysis of Costs and Subsidies

Following the computational procedures detailed in the Data and Methodology section above, we calculated (1) the cost to provide, (2) the fare payment received, and (3) the taxpayer subsidy required for each of 11,986 individual transit trips. These individual trip data were then aggregated into the demographic categories detailed in the previous section and are presented in the figures and table below.

Subsidy Variation by Service Type

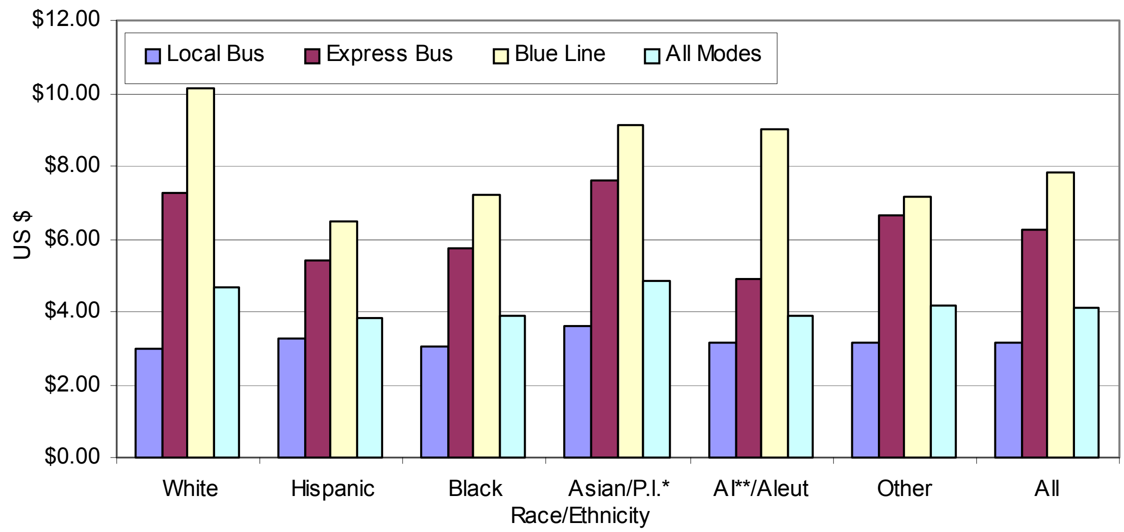
Figure 6.1 presents the calculated per trip subsidies for each type of service by income category. Across all income groups, per trip subsidies vary significantly by type of service; local bus passengers required a subsidy of $3.17 per trip, express bus passengers $6.28 per trip, and light rail passengers $7.85 per trip. Per trip bus subsidies do not vary much ($0.38) between the lowest and highest income categories. In contrast, per trip subsidies for light rail trips and, especially, express bus trips increase significantly with income. Per trip express bus subsidies for the highest income riders ($9.55) are nearly double those of the lowest income riders ($4.98).

Figure 6.1 Per Trip Subsidies for Service Types by Income



With respect to race/ethnicity, per trip subsidies across all modes are lowest for Hispanics ($3.81), blacks ($3.87), and Native Americans ($3.87), and highest for Non-Hispanic whites ($4.68) and Asian-Pacific Islanders ($4.85). Figure 6.2 shows that, as with income, per trip bus subsidies do not vary much (a range of $0.61) across racial/ethnic groups. But, as with income, per ride subsidies for express bus (a range of $2.67) and light rail (a range of $3.69) trips do vary substantially across racial/ethnic groups. Per trip express bus subsidies are lowest for Native Americans ($4.92) and Hispanics ($5.42) and highest for non-Hispanic whites ($7.26) and Asian-Pacific Islanders ($7.59). Similarly, per trip light rail subsidies are lowest for Hispanics ($6.48) and blacks ($7.19) and highest for Asian-Pacific Islanders ($9.14) and whites ($10.17).

Figure 6.2 Per Trip Subsidies for Service Types by Race/Ethnicity



The distribution of per trip subsidies for each type of service by age and sex are shown in Figures 6.3 and 6.4. In general, Figure 6.3 shows that per trip subsidies tend to be lower for younger riders and higher for older riders. With respect to sex, per trips subsidies of male rides are slightly higher than for women, though these differences are consistent across service type: bus (+$0.40), express bus (+$0.41), and light rail (+$0.57).

Figure 6.3 Per Trip Subsidies for Each Service Type by Age Group

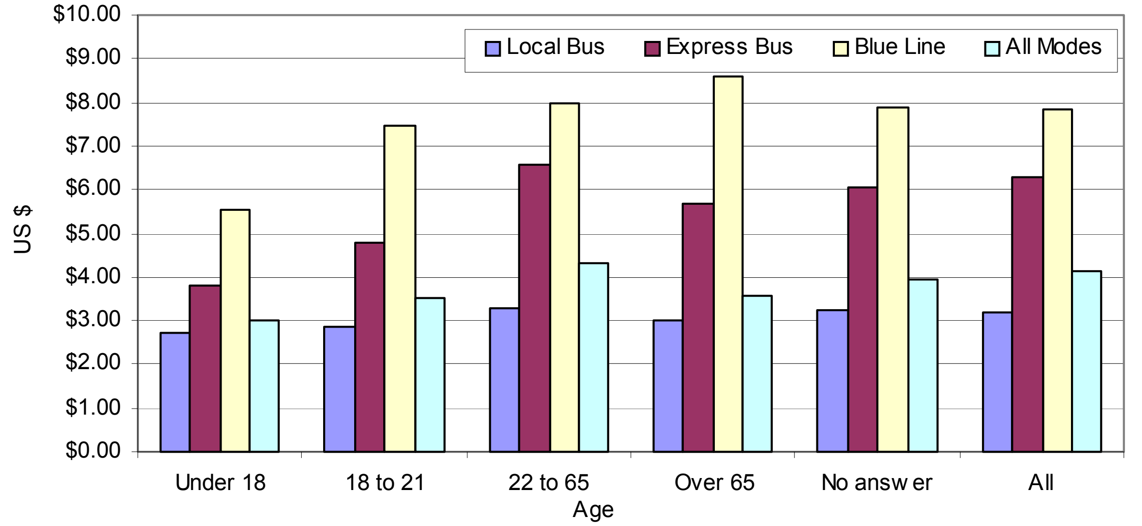
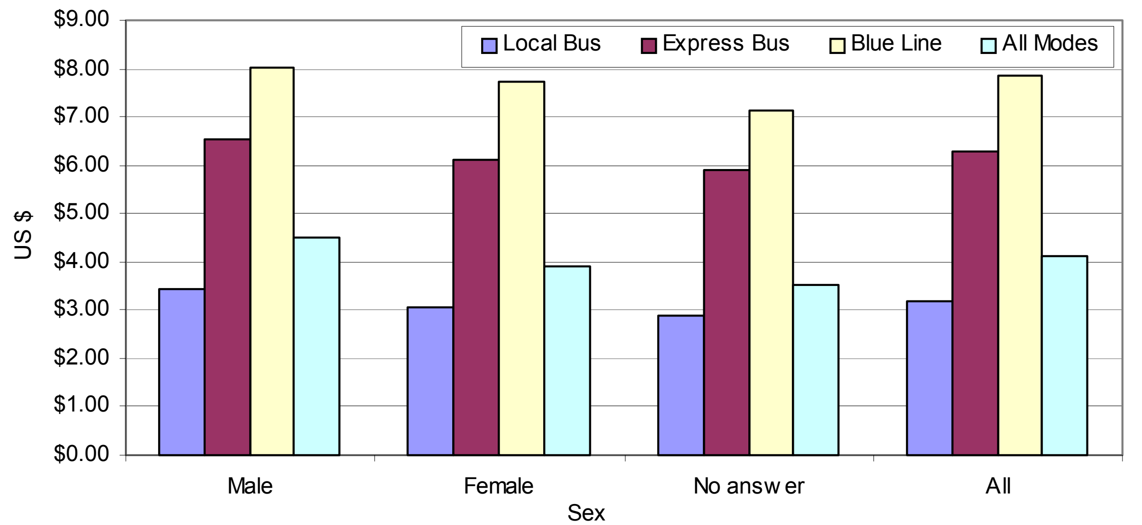


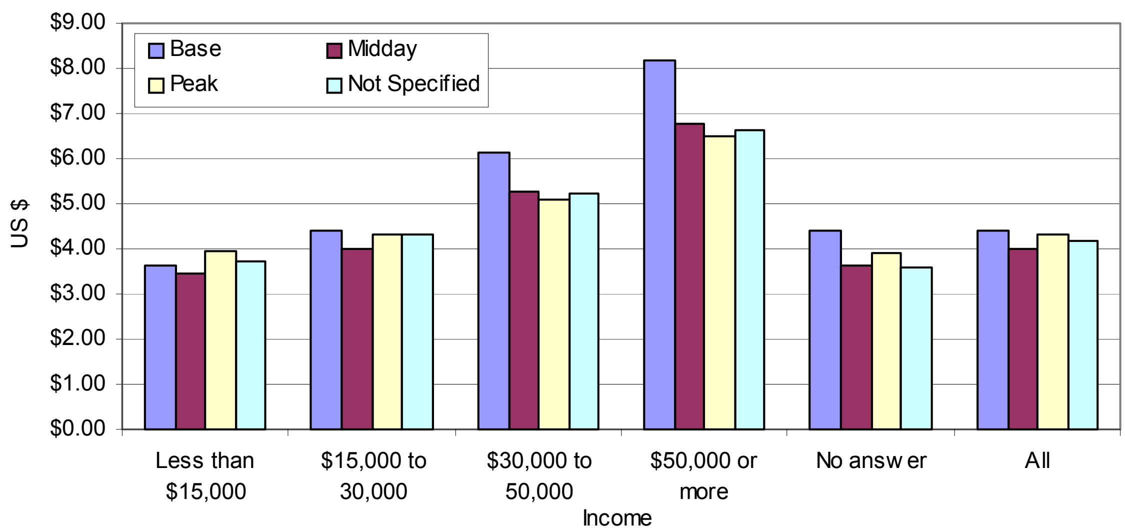
Figure 6.4 Per Trip Subsidies for Each Service Type by Sex



Subsidy Variation by Time of Day

Figure 6.5 presents the estimated per trip subsidies for three time periods by income category and shows that, across all income groups, per trip subsidies vary more by income group than by time of travel. Overall, per trip subsidies range only from $4.42 in the base period, to $4.00 in the midday period, and $4.33 in the peak period. In contrast, per trip subsidies vary significantly by income category. Per trip subsidies of base period riders from households with incomes greater than $50,000 are 124 percent higher than for riders from households with incomes below $15,000 -- a subsidy difference of $4.52 per trip. Likewise, per rider subsidies of higher-income midday riders exceeds those of low-income riders by 96 percent (or $2.29 per trip), while the same measures for peak period riders vary by 78 percent (or $1.55 per trip).

Figure 6.5 Per Trip Subsidies by Time of Day by Income



Factors Influencing Demographic Variation in Subsidies

The demographic differences in per rider subsidies measured here reflect systematic demographic patterns of transit service consumption. Consumers of short-distance local bus service require little subsidy, while consumers of long-distance express or rail service require substantially larger subsidies. In this analysis, demographic variation in average trip distance and mode/service type utilization explains most of the demographic variation in subsidy.

Table 6.1 summarizes the per trip costs, fares, subsidies for the trip characteristics and demographic categories presented in the previous figures. The table shows that the most significant observed differences in per trip subsidies are between modes (local bus and light rail, \$4.65 per trip) and between low and higher income travelers (\$3.15 per trip).

Much of the observed differences in per trip subsidies are due to the widely varying trip lengths among various demographic groups. Table 6.2 presents the per trip subsidies shown in Table 6.1, but controls for trip length. Among other things, it shows that fares paid vary demographically in patterns similar to subsidies received. That is, low-income passengers pay higher average fares per mile traveled than do higher-income riders. Correspondingly, black and Hispanic passengers pay higher average fares per mile than do Asian and non-Hispanic white riders. And male passengers pay lower fares per mile, on average, than do female passengers. Finally, but most significantly, local bus riders pay per mile fares that are *double* (\$0.12/mile compared to \$0.06/mile) those traveling on light rail. These differences in fares paid per mile reflect the combined effects of variation in average trip distances and, with the exception of express bus service, fares that do not vary with distance.

The effect of distance on per trip subsidies is illustrated by examining subsidy variance by income. While average per passenger subsidies vary from \$3.62 to \$6.77 as the income level rises, the variation in subsidies per mile increases only \$0.06 from \$0.50 to \$0.56 per mile. This is because average travel distance rises from 7.3 miles to 12.0 miles as income increases. Thus, most of the differences in subsidy levels by income are due to the longer average trip distances of high-income riders.

Table 6.1 Variation in Cost, Fare, and Subsidy per Trip by Trip Characteristics and Demographic Factors

		Cost per trip	Fare per trip	Subsidy per trip
All		$4.94	$0.82	$4.12
Service	Local Bus	$3.95	$0.77	$3.17
	Express Bus	$7.31	$1.03	$6.28
	Blue Line	$8.63	$0.79	$7.85
Time of Day	Base	5.22	$0.79	4.42
	Midday	4.81	$0.81	4.00
	Peak	5.18	$0.85	4.33
	Not Specified	4.98	$0.79	4.19
Income Level	Less than $15,000	$4.40	$0.78	$3.62
	$15,000 to 30,000	$4.95	$0.82	$4.13
	$30,000 to 50,000	$6.18	$0.91	$5.27
	$50,000 or more	$7.72	$0.95	$6.77
	No answer	$4.55	$0.81	$3.73
Race/Ethnicity	White	$5.47	$0.77	$4.70
	Hispanic	$4.67	$0.85	$3.82
	Black	$4.71	$0.82	$3.88
	Asian/P.I.*	$5.64	$0.76	$4.88
	AI**/Aleut	$4.68	$0.80	$3.88
	Other	$4.96	$0.78	$4.18
Sex	Male	$5.31	$0.81	$4.51
	Female	$4.76	$0.83	$3.93
	No answer	$4.34	$0.79	$3.55
Age	Under 18	$3.76	$0.75	$3.01
	18 to 21	$4.43	$0.88	$3.54
	22 to 65	$5.20	$0.86	$4.34
	Over 65	$3.88	$0.29	$3.58
	No answer	$4.77	$0.81	$3.96

*: Pacific Islander, **: American Indian.

Table 6.2 Variation in Fares and Subsidies per Mile Traveled by Trip Characteristics and Demographic Factors

		Subsidy per trip	Avg trip distance	Fare paid per mile	Subsidy per mile
All		$4.12	8.0	$0.10	$0.51
Service	Local Bus	$3.17	6.3	$0.12	$0.50
	Express Bus	$6.28	13.5	$0.08	$0.46
	Blue Line	$7.85	12.2	$0.06	$0.64
Time of Day	Base	4.42	8.1	$0.10	$0.54
	Midday	4.00	8.0	$0.10	$0.50
	Peak	4.33	8.2	$0.10	$0.53
	Not Specified	4.19	7.6	$0.10	$0.55
Income Level	Less than $15,000	$3.62	7.3	$0.11	$0.50
	$15,000 to 30,000	$4.13	8.1	$0.10	$0.51
	$30,000 to 50,000	$5.27	9.8	$0.09	$0.54
	$50,000 or more	$6.77	12.0	$0.08	$0.56
	No answer	$3.73	7.1	$0.11	$0.52
Race/Ethnicity	White	$4.70	8.8	$0.09	$0.53
	Hispanic	$3.82	7.7	$0.11	$0.50
	Black	$3.88	7.4	$0.11	$0.52
	Asian/P.I.*	$4.88	9.2	$0.08	$0.53
	AI**/Aleut	$3.88	8.3	$0.10	$0.46
	Other	$4.18	8.4	$0.09	$0.49
Sex	Male	$4.51	8.7	$0.09	$0.52
	Female	$3.93	7.7	$0.11	$0.51
	No answer	$3.55	6.9	$0.11	$0.51
Age	Under 18	$3.01	5.8	$0.13	$0.51
	18 to 21	$3.54	7.1	$0.12	$0.50
	22 to 65	$4.34	8.4	$0.10	$0.51
	Over 65	$3.58	6.4	$0.05	$0.55
	No answer	$3.96	7.6	$0.11	$0.52

*: Pacific Islander, **: American Indian.

Note: Average trip distance is measured in miles.

Costs and subsidies vary secondarily by mode/service type. While trips on both the express buses (13.5 miles) and light rail (12.2 miles) are much longer than local bus trips, controlling for trip distance does not explain the measured differences in fares or subsidies. LA MTA express buses employ distance-based fares, while the rail lines charge flat fares.[19] These fare differences combine with the much higher non-vehicle capital costs of the rail lines to make the per mile subsidy of light rail in Los Angeles 39 percent greater than for express buses. In contrast, while local bus service ($3.17) requires smaller per trip subsidies than either the express buses ($6.28) or light rail ($7.85), the subsidy per mile is actually a bit higher than on the express buses (due to the distance-based fares).

Finally, we measured very little variation in subsidies by time of day after controlling for trip distance and travel mode. Distance-normalized per trip subsidies do not vary significantly by time of day; per mile subsidies are $0.54 in the base period, $0.50 during Midday, and $0.53 in the peak periods. While unit costs of service supplied are higher during peak periods,[20] these higher costs are mitigated in the case of the LA MTA by higher levels of peak period utilization.

While the subsidies calculated here vary little by time of day, this does not imply that costs associated with peaking are not important. Shifting passengers from the off-peak to the peak would increase per passengers subsidies in both the off-peak and peak periods, while shifting passengers from the peak period to the off-peak (using, for example, off-peak fare

19 Although express bus fares increase with distance traveled, they do not proportionally track with travel distance.

20 Taylor, Garrett, and Iseki (2000) estimated peak-period LA MTA bus unit costs to be about 35 percent higher, and evening/night service about 15 percent lower than midday service. Given that the Los Angeles MTA has the third lowest peak-to-base vehicle ratio of any major U.S. transit operator, and the difference in cost and subsidy by time of day is most likely higher for most other transit operators.

discounts as an incentive) would decrease per passenger subsidies in both the off-peak and peak periods. In addition the very low levels of peaking on LA MTA service suggest that peaking may be far more of a cost and subsidy issue for other transit operators.

7 Conclusion

This paper reviews both the equity justifications for subsidizing public transit service and previous studies of transit subsidy equity. It then uses a set of multi-factor cost allocation models developed in an earlier phase of this research, and combines them with service consumption and travel survey data for the LA MTA to estimate the variation in subsidies by various demographic measures with far more precision than most of the previous research on this topic. We find that, on average, consumers of short-distance local bus service — who are disproportionately low-income, African-American or Latino, younger, and female — require substantially less subsidy per trip than consumers of long-distance express or rail service — who are disproportionately higher-income, Anglo or Asian, older, and male. While low-income residents in general benefit from the public subsidy of transit, this analysis finds that the benefits of transit subsidies disproportionately accrue to those least in need of public assistance. This raises serious questions regarding the conflicting objectives of transit system policies which seek to deploy services to attract both transit dependents and choice riders.

Because the subsidy of a transit trip is a function of the variable cost of that trip minus the fare paid by a traveler, the key to equalizing subsidies is fare policy. Most of the measured differences in per trip subsidies could be substantially reduced by the adoption of differentiated fare structures that more closely track variations in costs, especially in terms of travel distance (Cervero & Wachs, 1982). While such differentiated fare structures have been called for in the past, primitive fare collection technologies have greatly limited their application in practice. With the development of new "smart card" technologies, the barriers to implementing variable cost-based fare structures are quickly receding (Fleishman, 1996; Fleishman, et.al., 1998). Transit fares that vary to reflect the costs of service provision would increase equity in the use and subsidy of transit service. Encouraging passengers to consume more inexpensive-to-provide transit service (in particular, short, off-peak bus trips) on one hand, and encouraging them to be more judicious in their consumption of expensive-to-provide transit service (such as long distance, peak hour, peak direction trips) on the other would decrease overall subsidies per rider. In addition, equity would be increased by lowering (in relative terms) the price of transit services disproportionately consumed by low-income passengers and increasing (relatively) the price of transit services disproportionately consumed by higher-income passengers. In principle, these changes in fare policies would also increase efficiency in the provision of transit service (Cervero, 1981A; Cervero & Wachs, 1982; Wachs, 1989). Therefore, unlike many public policy dilemmas that pit equity *versus* efficiency, this research shows that the case of transit subsidies presents an opportunity to use fare policies to increase both equity *and* efficiency simultaneously.

Reference

American Public Transit Association. (1992). *Americans in Transit*. Washington, D.C.: American Public Transit Association.

American Public Transit Association. (1998). *Public Transportation Capital Funding Sources Statistics: National Totals.* [Online]. Available: <http://www.apta.com/stats/>.

American Public Transit Association. (1999A). *Public Transportation Capital Funding Sources Statistics: National Totals.* [Online]. Available: <http://www.apta.com/stats/>.

American Public Transportation Association. (1999B). *35 Largest Bus Transit Agencies, Fiscal Year 1999, Ranked by Number of Unlinked Passenger Trips*. [Online]. Available: <http://www.apta.com/stats/modesumm/35mbag.htm>.

Altsushuler, A., Pucher, J.R., Womack. (1979). *The Urban Transportation System: Politics and Public Innovation*. Cambridge: MIT Press.

Bates, John W. & Anderson, N. (1982, January). *Average Transit Trip Lengths by Racial and Income Classes in Atlanta: Equity of Flat Fares Based on Trip Length.* Presented at the 1982 Transportation Research Board Annual Meeting.

Black, A. (1995). Chapter 15: Pricing and financing. *Urban Mass Transportation Planning*. New York: McGraw-Hill, 362-363

Cervero, R. (1981A). Efficiency and equity impacts of current transit fare policies. *Transportation Research Record 799*, 7-15.

Cervero, R. (1981B). Flat versus differentiated transit pricing: What's a fair fare? *Transportation,* 10, 211-232.

Cervero, R. & Wachs, M. (1982). An answer to the transit crisis: The case for distance-based transit fares. *Journal of Contemporary Studies,* 5(2), 59-70.

Charles River Associates Incorporated. (1986). *Allocation of Federal Transit Operating Subsidies to Riders by Income Group.* CRA Report No. 784.15. Washington, D.C.: UMTA, U.S. Department of Transportation.

Charles River Associates Incorporated. (1989). *Transit Deficits: Peak and Off-Peak Comparisons.* CRA Report No. 784.30C. Washington, D.C.: UMTA, U.S. Department of Transportation.

Federal Transit Administration. (1998). *1998 National Transit Summaries and Trends*. [Online]. Available: <http://www.ntdprogram.com/NTD/NTST.nsf/NTST/1998/$File/98NTST.pdf>.

Ferreri, Michael G. (1979). Chapter 12: Comparative costs of transit modes. In G.E. Gray & H.A. Lester (Eds.), *Public Transportation: Planning, Operations, and Management*, Second Edition (pp. 225-252). Englewood Cliffs, NJ: Prentice-Hall.

Fleishman, D. (1994). *Transit Fair-Pricing Strategy in Regional Transportation*. Project H-06, FY 1994. Washington, D.C.: Transit Cooperative Research Program.

Fleishman, D., Schweiger, C., Lott, D., & Pierlott, G. (1996). *Multipurpose Transit Payment Media*. Project A-14, FY 1995. *TCRP Report 32*. Washington, D.C.: Transit Cooperative Research Program.

Garrett, M. & Taylor, B.D. (1999). Reconsidering social equity in public transit. In *Berkeley Planning Journal,* 13, 6-27.

Greene, D.L.., Jones, D.W., & Delucchi, M.A. (Eds.). (1997). *The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement.* Heidelberg, Germany: Springer-Verlag Berlin.

Hoachlander, E. G. (1976). *Bay Area Rapid Transit: Who Pays and Who Benefits?* Berkeley, University of California, Institute of Urban and Regional Development.

Hodge, D.C. (1988). Fiscal equity in urban mass transit systems: A geographic analysis. *Annals of the Association of American Geographers, 78*(2), 288-306.

Jones, D.W., Jr. (1985). Urban Transit Policy : An Economic and Political History. Englewood Cliffs, N.J. : Prentice-Hall, c1985.

Lem, L.L. (1997). Dividing the federal pie. *Access*, 10, 10-14.

Leutze, C.B. & Ugolik, W.R. (1978). Who pays the highest and lowest per-mile transit fare? Albany, NY: New York State Department of Transportation.

Meyers, Dowell. (1998, October). *Changing Demographics and Transportation Needs of the Future*. Paper presented at *Financing the Future: The Transportation - Land Use - Air Quality Connection*, Lake Arrowhead, CA.

Nash, C.A. (1988). Integration of public transport: An economic assessment. In J.S. Dodgson and N. Topham, (Eds.), *Bus Deregulation and Privatisation: An International Perspective*. (pp. 104, 106). Aldershot, U.K.: Gowan.

National Transit Database (NTD). (1998). *Thirty Largest Agencies for 1998*. [Online]. Available: <http://www.ntdprogram.com/NTD/Profiles.nsf/1998+30+Largest+Agencies/9154/$File/P9154.PDF>.

Nationwide Personal Transportation Survey. (1995). *Nationwide Personal Transportation Survey*. [Online]. Available: <http://www.bts.gov/ntda/npts/>.

Pisarski, A. (1996). *Commuting in America II: The 2nd National Report on Commuting Patterns and Trends*. Landsdowne, VA: Eno Transportation Foundation, Inc.

Price Waterhouse LLP. (1997). *Funding Strategies for Public Transportation*. Project H-07, FY 1995. *TCRP Report 31*. Washington, D.C.: Transit Cooperative Research Program.

Pucher, J.R. (1981). Equity in transit finance: Distribution of transit subsidy benefits and costs among income classes. *Journal of the American Planning Association*, *47,* 387-407.

Pucher, J.R. (1982). Discrimination in mass transit. *Journal of the American Planning Association, 48,* 315-326.

Pucher, J.R. (1988). Urban public transport subsidies in western Europe and North America. *Transportation Quarterly*, 42(3), 377-402

Pucher, J.R., Hendrickson, C., & McNeil, S. (1981, July). The socioeconomic characteristics of transit riders: some recent evidence. *Traffic Quarterly*, 461-483.

Pucher, J.R. & Williams, F. (1992, October). Socioeconomic characteristics of urban travelers: Evidence from the 1990-91 NPTS. *Transportation Quarterly, 46*(4), 561-581.

Pucher, J.R., Evans, T., & Wenger, J. (1998, Summer). Socioeconomics of urban travel: Evidence from the 1995 NPTS. *Transportation Quarterly, 52*(3), 15-33.

Rock, S. & Zavattero, S. (1979). Flat fares, transit trip distance, and income redistribution. *Proceedings of the Transportation Research Forum, 20*(1), 291-296.

Rosenbloom, S & Altsushuler, A. (1979). Equity issues in urban transportation. In Altshuler, A. (Ed.), *Current Issues in Urban Transportation Policy.* Lexington, MA: Lexington Books.

Small, K.A. & Gómez-Ibáñez, J.A. (1999). Urban transportation. In P. Cheshire and E.S. Mills (Eds.), *Handbook of Regional and Urban Economics, Volume 3: Applied Urban Economics* (pp. 1937-1999). Amsterdam: North-Holland.

Taylor, B. (1995). Program performance versus system performance: An explanation for the ineffectiveness of performance-based transit subsidy programs. *Transportation Research Record*, *1496*, 43-51.

Taylor, B.D., Garrett, M., & Iseki, H. (2000). Measuring cost variability in the provision of transit service. *Transportation Research Record, 1735,* 101-112.

U.S. Census Bureau. (1999). *1990 Decennial Census of Population and Housing Characteristics*. [Online]. Available: <http://www.census.gov/main/www/cen1990.html#counts>.

Vickrey, W.S. (1994). Marginal-cost pricing. In R. Arnott (Ed.), *Public Economics: Selected Papers by William Vickrey*. (pp. 198-215). Cambridge, MA: Cambridge University Press.

Young, I. M, & Hunold, C. (1988). Justice, democracy, and Hazardous Siting. *Political Studies, XLVI(2)*, 82-95.

Wachs, M. (1989). American Transit Subsidy Policy: In Need of Reform. *Science, 244*, 1545-1549.

Wabe, J.S., & Coles, O.B. (1975). The short and long-run cost of bus transport in urban areas. *Journal of Transport Economics and Policy, 9*(2), 127-140.

Webber, M. (1976, October). *The BART experience--what have we learned?* [Monograph]. Institute of Urban and Regional Development and Institute of Transportation Studies, University of California, Berkeley, 26, 1-40.