Urban Transit Profitability by Route and Time of Day

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One of the major initiatives of current federal urban transportation policy is to promote private-sector involvement in planning, operating, and financing urban mass transit services. One means of rapidly expanding private participation in the provision of urban transit service is for the public authorities that now operate almost all transit service in U.S. urban areas to contract with private firms to assume the operation of certain services. Many of the public authorities that now provide these services have objected that such contracting out would "skim the cream" from their systems. By this, they apparently mean that private firms would agree to acquire only those services that earn revenues in excess of their operating costs, thus leaving public authorities with increased deficits and no opportunities to cross-subsidize them from profitable sources. The question of whether the public authorities that currently provide mass transit services in the nation's urban areas are able to operate any of those services profitably is explored in this paper. A major conclusion is that extremely few, if any, urban transit services now operated by public agencies in U.S. cities generate farebox revenues sufficient to cover even their direct, day-to-day operating expenses. Furthermore, farebox coverage of operating expenses appears to be lowest for exactly those services in which both actual and potential private participants have exhibited the greatest interest, so that there appears to be little risk that widespread contracting out of urban transit service will produce increased deficits for any of its current operators.

One of the major initiatives of current federal urban transportation policy is to promote private-sector involvement in planning, operating, and financing urban mass transit services, which have, during the last 2 decades, come to be almost universally owned and managed by government agencies (*1*). During 1965, less than one-half of all transit vehicles were owned by public agencies; but by 1983, such agencies owned 93 percent of the vehicles, provided 95 percent of all service, and carried 95 percent of all transit passengers. The Federal Private Enterprise Participation Policy Statement, issued by UMTA during 1984, states in part that "when developing federally assisted mass transportation plans and programs, UMTA grantees should give timely and fair consideration to the comments on proposals of interested private enterprise entities in order to achieve *maximum feasible private participation*" (emphasis added) (2,p.86). Despite some very recent increases in participation by private transit operators, very little of the conventional transit service in the United States is now operated by private suppliers, either independently or under contract to public transit authorities and regional transportation agencies responsible for providing it.

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One means of rapidly expanding private participation in the provision of urban transit service is for the public authorities that now operate almost all of the services to contract with private firms to assume the operation of some of them. The variety of potential candidates for contracting out is wide, but the most logical starting points probably are some fixed-route bus operations, particularly peak-hour express routes and local suburban service, commuter railroad service, and various demand-responsive or paratransit services. Although contracting out has already been extensively employed for demand-responsive service, and commuter rail service is commonly operated by railroad companies under contract to public transit authorities, only about 2 percent of all conventional bus transit service in the United States is currently operated by private firms on a contract basis (2,p.84).

THE CONTROVERSY

Some of the public authorities currently providing urban mass transit services have objected that contracting out would "skim the cream" from their systems. By this, they apparently mean that private firms would agree to acquire only those services that earn revenues in excess of their operating costs, thus leaving public authorities with increased deficits and no opportunities to cross-subsidize them from profitable sources. Representative William Lehman, Chairman of the Transportation Subcommittee of the House Committee on Appropriations, voiced this concern during the subcommittee's May 1985 hearings when he commented that privately operated transit services were desirable only "as long as they do not drain off the best routes from the public transportation [operators] so that public transportation is just left with the more costly to operate types of routes (*3*).

Some advocates of privatization have responded that public transit authorities may be unable to cover the costs of operating any of the services they currently supply, but that private suppliers might be able to operate some routes or types of service at considerably lower costs than the public agencies that currently provide them, thus reducing the subsidy levels necessary to maintain such services. In response to Representative Lehman's concern, for example, one of those testifying before the subcommittee cautioned its members that "public transit authorities lose money on both these ostensible 'cream' passengers and on the others that they carry . . . I think it is a mistake to accept uncritically the argument that by skimming off peak-hour passengers, passengers on express-type services, and others for which higher fares are sometimes charged, that public transit operators would actually see their deficits grow" (*3*).

Explored in this paper is the question of whether, in the parlance of the industry, there remains any cream to skim. In other words, the ability of public authorities, which currently provide almost all mass transit service in the nation's urban areas, to operate any of those services profitably is investigated. The term "profitable" is defined in the next section. Subsequent sections review the available empirical evidence on the effect of type of service (in terms of route and time period) on transit costs and revenues in order to test whether any transit service currently generates farebox revenues sufficient to meet the definition of profitability.

WHEN IS TRANSIT SERVICE PROFITABLE?

To meet the economist's definition of profitability, a transit service must generate revenues sufficient to cover its expenses for labor, energy, materials, and other operating inputs, as well as to produce some return to its invested capital. Furthermore, for a service to be self-sustaining, this return must suffice to attract new capital at a rate that maintains the total investment necessary to operate it. In urban transit, however, a service is typically said to be profitable if it generates farebox revenues that exceed its direct operating expenses, without any allowance for the depreciation or interest costs for vehicles or fixed-capital facilities dedicated to its provision. A service's direct operating expenses, moreover, are often defined to exclude any allowance for administrative costs or other overhead-type expenses, although at other times expenses include a simple proportional allocation of these cost categories. This situation may occur because there are a number of difficult conceptual problems in allocating expenses that are genuinely common to more than one category of service; however, it may also be a response to the difficulty of taking the actions necessary to reduce these costs when service levels are curtailed.

Although the accounting systems of most public transit operators sometimes make the allocation of farebox revenues among types of service, specific routes, and occasionally even time periods of the day a relatively straightforward process, they generally do not permit ready identification of the costs of operating different categories of service. Judgmental procedures are generally required to allocate the expense categories appearing in transit operators' accounting systems to any desired subdivision of the agency's activities, such as operating divisions, individual routes, or time periods. Thus, not only is the definition of what constitutes profitable service a difficult matter, but the actual measurement of whether individual service categories meet any particular definition is also problematic.

In an effort to minimize these potential difficulties, a very narrow definition of the profitability of individual transit service categories is adopted here. Specifically, the relationship between farebox revenues and direct, day-to-day expenses for various categories of transit service currently operated by a number of different public agencies is investigated. Direct operating expenses are defined to include only labor, energy, and material costs for operating and maintaining vehicles, plus an allowance for investments in and use-related depreciation (as contrasted with depreciation that occurs solely because of the passage of time) of any vehicles that are dedicated to the provision of that service. All expenses for operation and maintenance of fixed facilities (e.g., garages, depots, stations, etc.) and rights-of-way, as well as all expenses for supervisory and administrative functions, are specifically excluded from the definition of direct costs employed here. The major reason for adopting such a conservative definition of costs is to match as closely as possible those expenses that would be instantaneously eliminated by a public agency that successfully contracted with a private supplier to take over a specific service it now operates. Any category of transit service that fails to meet the profitability test under this definition of costs necessarily contributes to increasing the financial deficit of its operator, and its elimination would thus unarguably reduce that deficit.

THE OPERATING RATIO COMPLICATION

Somewhat surprisingly, contracting out or otherwise eliminating a service that now produces a deficit under this definition can actually reduce the fraction of its operator's expenses that is covered by fare revenues, while also raising the deficit per passenger on that operator's remaining services. (A service's farebox receipts expressed as a percentage of its operating expenses are commonly referred to as its operating ratio, although this actually corresponds to the reciprocal of the traditional accounting definition of that term. This measure is also often termed the farebox coverage ratio.) This result has occasionally been used to argue that transferring such services to unsubsidized private providers will leave the public agency that now operates them in worse financial condition than if it continued to operate them and cover a low percentage of their expenses from farebox revenues. Nevertheless, it is important to recognize that the opposite is true.

To see that this is the case, suppose a transit authority operates service on two routes: one offering peak-hour express service at a fare of $1.00 per passenger, and the other offering all-day local service at a fare of 50 cents per rider. Suppose each route costs the authority $1,000 per day to operate, and that each service attracts 600 paying riders each day. Thus, the express service earns total daily revenues of $600, leaving a daily operating deficit of $400, and has a farebox coverage ratio of 60 percent (the $600 in daily fare revenue it generates expressed as a percentage of its $1,000 daily operating expense). Similarly, the local route produces $300 in daily revenue, leaving a daily deficit of $700, and thus generates only 30 percent farebox coverage of operating expenses. In total, the operator of these two routes incurs a daily total deficit of $1,100, or about 92 cents per passenger, and covers 45 percent ($600 plus $300 in daily revenues from the two routes divided by the $2,000 total daily expense for the two routes) of its operating expenses from the farebox.

If the express service were to be assumed by an unsubsidized private operator, some financial statistics for the public agency that continued to operate the local route would indeed appear to be worse: farebox coverage of expenses would decline to the 30 percent figure of the local route, and the deficit per passenger would rise to about $1.17 (the $700 daily deficit incurred in operating the local route divided among the 600 passengers it carries). More important, however, the remaining total deficit would have declined from the initial $1,100 to the $700 figure generated by the local route because the $400 daily deficit on the express route would have been eliminated. In fact, the public agency that formerly operated the express route could subsidize the private operator to which it was transferred or contracted at a rate of up to $399 daily and still reduce its total daily deficit for providing the two types of transit service.

The most visible transit services for which this example is relevant are probably the peak-hour express services currently operated by many public transit agencies, often including commuter railroad service, which is already mainly operated by private railroad companies under contract to public transit agencies. Typically, fares charged for such services are considerably higher than those for regular local bus service, and these premium fares are often sufficient to raise farebox coverage ratios on express service well above their operators' systemwide averages. Nevertheless, these services are often among the most imortant sources of their operators' total deficits simply because their operating costs are so high. For example, one study revealed that express bus routes in Los Angeles covered nearly 40 percent of their operating costs from fare revenues—a figure exceeded at that time only on routes serving central city areas—but still accounted for nearly one-quarter of their operator's total deficit (*4*). Thus contracting the operation of such services to lower-cost private providers might in some cases substantially reduce their current suppliers' total deficits.

TYPES OF TRANSIT SERVICE STUDIED

One useful way to classify transit service is according to the orientation of routes over which vehicles operate and the time period during which service is provided. The service provided by a typical large urban transit authority can be subdivided into various categories using routes and time periods as specified in Table 1. The costs of operating transit services are likely to differ considerably among these different categories, mainly because the productivity with which operators and vehicles can be utilized in each type of service varies widely. Among the most important factors responsible for this are peaking in scheduled service levels during morning and evening commuting hours on some routes, together with provisions of transit operators' labor contracts that restrict the duration of driver work shifts, the use of split shifts, and the hiring of part-time drivers. Other important sources of labor productivity differences among types of transit service are (*a*) varying amounts of nonrevenue service they require (due to vehicle deadheading and layover allowances, for example); (*b*) variation among routes and time periods in the speeds at which transit vehicles can operate in revenue service; and (*c*) differences among passenger trip lengths with route orientation and time periods.

TABLE 1 CLASSIFICATION OF TRANSIT SERVICE TYPES BY TIME PERIOD AND ROUTE LOCATION

	Time Period When Service Operates		
Route Orientation	Weekday Peak	Midday and Night	Weekend and Holiday
CBD[a]-bound radial	XX[b]		
Intown local	XX	XX	
Suburban local		XX	XX
Crosstown or intersuburban			
Rail-system feeder	XX		

[a]Central business district.
[b]XX denotes current participation or apparent interest by private transportation operators in providing this type of service.

In addition, the demand for transit service in most urban areas differs substantially among the types of routes given in Table 1, as well as among the different time periods of the day and week. Some transit operators also impose higher passenger fares for specific services or at certain times of the day, most commonly for radial express routes and during weekday peak hours, while others employ zone surcharges to impose higher fares for longer trips. Together, these factors introduce substantial variation in passenger volumes, average fares actually paid, and the resulting total farebox revenues among the various categories of transit service that are identified in Table 1. In conjunction with variation among these categories in the costs of operating service, these differences in revenue can produce substantial variation in farebox coverage of expenses and operating deficits among individual types of service. If there is any profitability or "cream to skim" within the financial structures of U.S. urban transit systems, it seems most likely to be revealed by an analysis of variation in operating costs and farebox revenues among the categories of transit service identified in Table 1.

EVIDENCE ON VARIATION IN TRANSIT COSTS

A substantial amount of recent research has focused on assessing variation in the costs of supplying transit service of the different types identified in Table 1. This research consists primarily of studies that judgmentally allocate transit agencies' itemized expense accounts to the different services they supply, usually by assigning individual accounts to output measures such as vehicle hours or vehicle miles of transit service (see also *5,6*). This creates estimates of the unit costs for producing each of these outputs, which are then applied to the actual output levels—again, vehicle hours and vehicle miles are the most commonly used of these cost factors—involved in operating a specific service in order to estimate its separate cost. Expenses for management, planning, administration, and other overhead activities are sometimes allocated among individual categories of service, most commonly on the basis of the number of vehicles assigned to each route, time period, or combination of the two, such as the number of vehicles required to operate peak-hour service on each route.

Summarized in Table 2 (*6–12*) are the results of a number of these cost allocation studies that have been documented in recent publications. (Only those studies that describe their results in sufficient detail to allow the examination of cost and revenue variation by individual route, operating division, or service type were used in this research.) As indicated in Table 2, virtually all of the studies report estimates of expenses per vehicle hour and per vehicle mile of service, which were developed by allocating individual operating cost accounts to the output measure with which the authors of the various studies thought they were likely to vary most directly. These unit cost estimates are then applied to the actual numbers of those outputs used to operate different routes or services, which are also reported in Table 2. Finally, each researcher has assigned administrative and other overhead costs to individual routes or services on the basis of some other variable, such as the number of vehicles operated in peak service, also reported in Table 2.

Several adjustments to the various authors' cost estimates reported in Table 2 were necessary to make them useful for investigating the profitability of transit services as defined for the purpose of this study. First, all administrative and other overhead expenditures that are allocated to individual routes or types of service by various researchers are subtracted from their cost estimates because it is unlikely that these expenses would be immediately reduced in exact proportion to any reduction in vehicle requirements or other variables that resulted from a decision to contract out specific services. In fact, it is not clear whether some of these expenses would be reduced at all if the amount of service contracted out represents a small part of the total currently in operation.

Second, the various researchers' estimates of operating expenses per vehicle hour and per vehicle mile were also adjusted downward to eliminate all expenditures other than direct costs for operating the various individual services. As discussed previously, these are defined to include only driver and mechanic labor, energy, and materials expenses for operating and maintaining vehicles. Thus, for example, all expenditures for supervision and administration of vehicle maintenance are excluded wherever they can be determined, as are all expenses associated with operating fixed facilities, such as maintenance garages and vehicle storage areas. Again, the rationale for excluding even these semidirect or variable overhead expenses, as they are often termed, is to produce an estimate of expenses that would vary immediately with changes in service levels. This, in turn, provides an estimate of the minimum cost saving that would immediately and directly result from any decision to reduce service levels, such as to contract out.

A third adjustment is also required in order to render some researchers' estimates of the costs per hour of operating bus transit service a more accurate reflection of the differences in effective wage rates and productivity levels of vehicle operators during peak and off-peak periods. This adjustment, commonly made by transit analysts, raises operating expenses per vehicle hour during peak periods to account for the fact that various pay provisions of drivers' labor contracts, such as minimum guarantees and pay premiums for long or split shifts, raise their effective hourly wage rates during peak periods (*13*). The adjustment also raises estimated peak hourly costs to account for the effect of contractual restrictions on the number and duration of split shifts, which combine with peaking in the demand for transit service to reduce drivers' productivity (the number of hours of passenger-carrying service actually produced per hour for which a driver is paid) during peak periods. The combined effect of these two adjustments is typically to raise estimated expenses per vehicle hour during peak periods by 15 to 20 percent above their overall average value for all time periods (*13*). At the same time, both of these adjustments reduce the estimated costs of operating service during nonpeak periods, most commonly to a level some 10 to 15 percent below their 24-hr average value.

Finally, an allowance for the capital costs of transit vehicles is added to the various researchers' estimates of transit operating expenses. This cost has two separate components, the first of which represents the actual depreciation of transit vehicles with accumulated usage. In contrast to passenger cars, depreciation of transit vehicles appears to be almost exclusively the product of actual use rather than simply of the passage of time, although common industry procedures governing the utilization of buses and the accounting of expenses make it difficult to recognize this (*14*). The estimated allowance for vehicle depreciation, which amounts to about $0.375 per mile over the typical lifetime of conventional transit buses, is added to the estimates of operating expenses per vehicle mile, computed as "straight-line" depreciation of a new bus costing $150,000 over a 400,000-mi useful lifetime. The cost is allocated to vehicle usage in whatever category of service it occurs because it could be reduced in exact proportion to any service reduction by redeploying vehicles to another service, holding them as spares, or selling them to other transit operators.

The other component of capital costs for vehicles represents the interest expense for financing their owners' investments in buses and rail vehicles. At current interest rates (approximately 7 percent after adjusting for anticipated inflation), this cost ranges from $25 to $28 per day for transit buses with typical initial purchase prices of $150,000 and utilization rates of 30,000 to 50,000 mi per year. All of this cost is allocated to peak-period service on the route or service category in question because only by reducing peak-period service levels and vehicle requirements would the number of vehicles purchased (and thus total vehicle financing costs) actually be reduced. Although the costs of vehicle ownership to U.S. urban transit operators are heavily subsidized, particularly by the federal government, most large public transit authorities have bus purchase needs that more than exhaust their available capital subsidies under current allocations. Those that do face the full unsubsidized cost of financing capital investments in the acquisition of additional vehicles, and the savings in these costs that would result from reductions in peak service through contracting out, are thus equal to the unsubsidized interest cost of financing additional bus purchases.

Summarized in Table 3 are the revised estimates of various researchers' reported cost figures that result from applying the various adjustments. Comparing the daily cost estimates for individual services originally reported in Table 2 with the revised values in Table 3 reveals that these adjustments increase some of the authors' reported cost estimates by 5 to 10 percent, primarily because the estimates in Table 3 incorporate some allowance for capital costs, but reduce other researchers' original operating cost estimates to about the same extent. These adjustments also tend to increase the estimated differential between peak and off-peak costs for operating the various services. More important, however, the adjusted costs reported in Table 3 represent more realistic estimates of those expenses that could be immediately eliminated by reducing service, such as those that would result from a decision to contract the operation of some route or entire category of service to a private operator. These revised estimates can then be compared to the farebox revenues generated by the various categories of

TABLE 2 DEVELOPMENT OF OPERATING COST ESTIMATES FOR VARIOUS URBAN TRANSIT SERVICES

					Unit Cost Factors			Daily Operation Inputs Required			
Urban Area	Researcher	Data Year	Type of Service	No. of Routes	$/Vehicle Hours	$/Vehicle Miles	Other	Vehicle Hours	Vehicle Miles	Other	Estimated Daily/ Hourly Operation Cost ($)
Los Angeles	Gephart	1984	Express	1	33.09	0.99	138.73 PO*APB/TB[a]	49.8	1,441	(10+10)(10/10)	5,849/117.45
			Intown	1							
			Peak		30.27	1.14	107.30 PO*APB/TB	37.8	300	(7+9)(8/20)	1,787/47.27
			Off peak		27.10	1.14	107.30 PO*BB/TB	60.5	393	(7)(12/20)	2,538/41.95
			Suburban	1							
			Peak		30.27	1.14	107.30 PO*APB/TB	32.0	472	(5+2)(5.5/9.5)	1,941/60.67
			Off peak		27.10	1.14	107.30 PO*BB/TB	47.6	415	(5+2)(4/9.5)	2,079/43.68
Los Angeles	Wells, Williams	1982	Express								
			Subscription	8	27.90	1.22	109.07/PV-day[b]				4,016
			Park and ride	9	27.90	1.22	109.07/PV-day				34,471
Los Angeles	Cox	1980	Express	?							72,000
			Peak		20.64	0.79	68.92/PV-day				
			Nonpeak		15.86	0.79	68.92/PV-day				
			Intown	?							384,400
			Peak		20.64	0.79	68.92/PV-day				
			Nonpeak		15.86	0.79	68.92/PV-day				
			Suburban	?							147,100
			Peak		20.64	0.79	68.92/PV-day				
			Nonpeak		15.86	0.79	68.92/PV-day				
Orange County	Wells, Williams	1982	Park and ride	5	20.55	0.95	103.60/PV-day				3,702
San Diego	Cervero	1978	Radial	3							
			Peak		23.73	0.43	+3.4% capital[c]	185.0	3,662	31*	6,168/33.34
			Nonpeak		17.50	0.43	+0.6% capital	166.8	3,258	15*	4,346/26.05
			Intown	2							
			Peak		24.75	0.43	+3.4% capital	95.0	889	16*	2,734/28.77
			Nonpeak		17.83	0.43	+0.6% capital	129.5	1,204	12*	2,844/21.96
			Suburban	5							
			Peak		23.67	0.43	+3.4% capital	101.0	1,508	17*	3,142/31.11
			Nonpeak		19.09	0.43	+0.6% capital	176.3	2,655	16*	4,534/25.72

Oakland	Cervero	1979	Express	3							
			Peak only		18.62	0.29	+27.8% OH[d]	275.8	5,861	69*	8,735/31.67
			Radial	4							
			Peak		20.01	0.27	+27.8% OH	484.7	5,846	122*	14,412/29.73
			Nonpeak		17.32	0.27	+2.0% OH	676.8	8,477	50*	14,291/21.16
			Intown	3							
			Peak		19.46	0.27	+27.8% OH	108.9	1,332	28*	3,168/29.09
			Nonpeak		17.43	0.27	+2.0% OH	122.2	1,568	9*	2,604/21.31
			Suburban	5							
			Peak		18.71	0.23	+27.8% OH	242.9	4,965	61*	7,521/30.96
			Nonpeak		18.67	0.24	+2.0% OH	90.2	1,223	7*	2,017/22.36
			Rail feeder	5							
			Peak		18.97	0.28	+27.8% OH	142.5	1,762	36*	4,085/28.67
			Nonpeak		17.97	0.28	+2.0% OH	138.6	1,738	11*	3,037/21.91
San Francisco	Dornan	1980	Commuter rail	1	–	6.81	–	–	8,105	–	55,184
New York	Walder	1981	Peak-only express								
			Yukon	6	27.55	0.60	219.90/PV-day	814.6	15,952	115	50,871/62.45
			Castleton	3	26.82	0.86	189.08/PV-day	187.1	4,051	30	14,174/75.76
			Combined	9	27.41	0.65	213.52/PV-day	1,001.7	20,003	145	65,045/64.93
	Dornan	1980	Commuter rail	?	–	6.87	–	–	162,530	–	1,116,581
Boston	Carey, Campbell	1981	Express	3							
			Peak		30.37	0.86	554.70/PV-day	60.2	761	8*	3,110/51.67
			Nonpeak		27.04	0.86	0	40.3	480	4*	1,222/30.33
			Radial[e]	4							
			Peak		30.37	0.86	554.70/PV-day	147.4	1,356	19*	6,860/46.54
			Nonpeak		27.04	0.86	0	132.1	1,216	12*	3,592/27.19
			Crosstown[f]	7							
			Peak		30.37	0.86	554.70/PV-day	165.8	1,424	21*	8,040/48.49
			Nonpeak		27.04	0.86	0	101.6	873	10*	2,740/26.97
			Suburban	2							
			Peak		30.37	0.86	554.70/PV-day	14.7	217	2*	743/50.52
			Nonpeak		27.04	0.86		5.8	87	1*	189/32.64
	Dornan		Commuter rail	9	–	6.79	–	–	25,875	–	175,691
Washington, D.C.	Dornan	1980	Commuter rail	2	–	9.50	–	–	2,316	–	22,002
Pittsburgh			Commuter rail	2	–	3.93	–	–	2,944	–	11,540
Detroit	Dornan	1980	Commuter rail	1	–	10.22	–	–	830	–	8,482

Note: * = estimated from vehicle hour data assuming (*a*) uniform within-peak service pattern, and (*b*) no nonrevenue service during peaks. OH indicates an added allowance for overhead costs equal to the stated percentage of total vehicle hours plus vehicle mile costs.

[a]PO indicates total daily bus pullouts, defined as the number of buses employed in morning peak service plus the number used to operate evening peak service that were not used for midday service. APB indicates available peak buses, the average of the numbers needed for morning and evening peak period service, and BB indicates base buses, the average number of buses used to provide midday base period service.

[b]PV-day indicates a daily dollar cost allocation per vehicle necessary to operate scheduled peak service on a route.

[c]Factors added to direct operating costs to account for estimated capital charges for vehicles and fixed facilities; thus for example, total operating costs in peak service are estimated to be 103.4 percent of direct operating expenses.

[d]Factors added to direct operating costs to account for estimated general overhead expenses; thus for example, total operating costs in peak service are estimated to be 127.8 percent of direct operating expenses.

[e]Hybrid radial trunk and rail feeder routes.

[f]Circumferential routes; intown travel served by rail system.

TABLE 3 ADJUSTMENT OF VARIOUS RESEARCHERS' OPERATING COST ESTIMATES TO A CONSISTENT BASIS

			Revised Cost Factors[a]			Daily Inputs Assigned			Estimated Study Date Daily Cost
Urban Area	Type of Service	No. of Routes	$/Vehicle Hours	$/Vehicle Miles	$/Vehicle Days	Vehicle Hours	Vehicle Miles	Vehicles	($)
Los Angeles	Peak express	14	31.49	1.08	28.52				72,000
	Intown	Many							384,400
	Peak		28.80	1.19	28.52				
	Nonpeak		25.79	1.19	0				
	Suburban	Many							147,100
	Peak		28.80	1.19	28.52				
	Nonpeak		25.79	1.19	0				
San Diego	Radial	3							12,811
	Peak		21.44	0.77	28.37	185.0	3,662	31	7,666
	Nonpeak		15.81	0.77	0	166.8	3,258	15	5,146
	Intown	2							6,276
	Peak		22.36	0.77	28.37	95.0	889	16	3,263
	Nonpeak		16.11	0.77	0	129.5	1,204	12	3,013
	Suburban	5							8,890
	Peak		21.39	0.77	28.37	101.0	1,508	17	3,804
	Nonpeak		17.25	0.77	0	176.3	2,655	16	5,086
Oakland	Peak express	3	18.62	0.67	27.87	275.8	5,861	69	10,985
	Radial	4							34,131
	Peak		20.01	0.65	27.87	484.7	5,846	122	16,899
	Nonpeak		17.32	0.65	0	676.8	8,477	50	17,232
	Intown	3							6,914
	Peak		19.46	0.65	27.87	108.9	1,332	28	3,765
	Nonpeak		17.43	0.65	0	122.2	1,568	9	3,149
	Suburban	5							11,715
	Peak		18.71	0.61	27.87	242.9	4,965	61	9,273
	Nonpeak		18.67	0.62	0	90.2	1,223	7	2,442
	Rail feeder	5							8,507
	Peak		18.97	0.66	27.87	142.5	1,762	36	4,869
	Nonpeak		17.97	0.66	0	138.6	1,738	11	3,638
San Francisco	Commuter rail	1	–	5.79	–	–	8,105	42[b] 73[c]	46,928
Boston	Express	3							4,655
	Peak		30.37	1.24	24.75	60.2	761	8	2,970
	Nonpeak		27.04	1.24	0	40.3	480	4	1,685
	Radial	4							11,708
	Peak		30.37	1.24	24.75	147.4	1,356	19	6,628
	Nonpeak		27.04	1.24	0	132.1	1,216	12	5,080
	Crosstown	7							11,151
	Peak		30.37	1.24	24.75	165.8	1,424	21	7,321
	Nonpeak		27.04	1.24	0	101.6	873	10	3,830
	Suburban	2							1,030
	Peak		30.37	1.24	24.75	14.7	217	2	765
	Nonpeak		27.04	1.24	0	5.8	87	1	265
	Commuter rail	9	–	6.79	–	–	25,875	37[b] 177[c]	132,739
New York	Peak express	9	27.41	1.03	25.81	1,001.7	2,003	145	51,858
	Yukon	6	27.55	0.98	25.81	814.6	15,952	115	41,043
	Castleton	3	26.82	1.24	25.81	187.1	4,051	30	10,815
	Commuter rail	Many	–	6.87	–	–	162,530	67[b] 250[c] 764[d]	785,020
Washington, D.C.	Commuter rail	2	–	9.50	–	–	2,316	5[b] 32[c]	20,057
Pittsburgh	Commuter rail	2	–	3.62	–	–	2,664	4[b] 15[c]	10,657
Detroit	Commuter rail	1	–	10.22	–	–	830	5[b] 23[c]	7,528

[a]Author's reported unit cost factors are adjusted downward to eliminate any fixed overheads included in reported estimates. Use-related vehicle depreciation is allocated to vehicle miles; interest costs are included in vehicle day unit cost and allocated entirely to peak service.
[b]Local.
[c]Coach.
[d]Spare car.

service in order to assess whether any of them meet the test of profitability proposed here.

FAREBOX REVENUES BY TYPE OF TRANSIT SERVICE

Variation in farebox revenues among transit services stems from two basic sources: (*a*) variation in the demand for different types of service, which determines the number of riders that will use each type at any given fare level; and (*b*) differences in fares charged among individual routes or types of service. Demand variation largely reflects the geographic distributions of residences, employment, and other urban land uses that, together with normal time patterns in social and economic activities, produce substantial variation in urban travel patterns by location, direction, and time of day. In addition, many U.S. urban transit operators charge fares that vary by type of service, time of the day, or length of trip, although these differences are usually quite modest. During 1981, only 9 percent of U.S. transit systems charged higher fares during peak level hours (with an average differential between peak and off-peak fares of approximately 27 percent), while 37 percent of transit operators imposed higher fares for longer trips, and 38 percent charged higher fares for premium services such as express routes (*15*). [Two prominent exceptions to the pattern are commuter railroad service in various urban areas and peak express bus service in New York City, for which sharply higher fares (from $1.00 to $3.10) are charged.]

The combined effect of differences in the demand for transit service by time of day, geographic orientation or route, and variation in fare levels produces substantial differences in ridership and total revenues among different types of urban transit service. Given in Table 4 (*6–12*) are the estimates of average daily ridership, average fare revenue per passenger, and average daily total fare revenue generated by each of the transit services for which operating cost estimates were given in Tables 2 and 3. As the figures in Table 4 indicate, there is considerable variation in farebox revenue among different types of transit routes or services and time periods of the day, even within individual transit systems. Also, as indicated in Table 4, most of this variation is introduced by differences in the demand for different types of service, as reflected in the wide variation in ridership levels among route types and time periods, rather than by variation in fares charged for different types of service.

Part of the variation in average fare revenue per passenger among types of urban bus routes may also reflect different levels of travel on specific routes by passengers who are entitled to fare discounts under their operators' fare policies. Some of these fare discounts are required as conditions for receiving federal transit operating assistance (notably half-fare discounts to elderly and handicapped passengers riding during off-peak periods), and the revenue estimates given in Table 4

TABLE 4 DEVELOPMENT OF FAREBOX REVENUE ESTIMATES FOR VARIOUS URBAN TRANSIT SERVICES

Urban Area	Researcher	Year	Type of Service	No. of Routes	Average Daily Ridership	Average Fare/Rider ($)	Average Daily Fare Revenue ($)
Los Angeles	Cox	1984	Peak express	14	41,500	0.549	22,800
			Intown	Many	881,600	0.158	139,200
			Suburban	Many	136,600	0.276	37,700
San Diego	Cervero	1979	Radial	3	9,862	0.345	3,403
			Peak		8,101	0.355	2,876
			Nonpeak		1,761	0.299	527
			Intown	2	11,226	0.345	3,873
			Suburban	5	5,315	0.345	1,834
SF Bay Area	Cervero	1979	Peak express	3	4,641	0.339	1,573
			Radial	4	52,663	0.289	15,220
			Intown	3	3,573	0.289	1,033
			Suburban	5	3,296	0.289	953
			Rail feeder	5	7,617	0.289	2,201
	Dornan	1980	Commuter rail	1	20,376	1.204	24,553
Boston	Carey, Campbell	1981	Express	3	3,519	0.537	1,890
			Peak		2,708	0.537	1,454
			Nonpeak		811	0.537	436
			Other radial	4	14,962	0.396	5,925
			Crosstown	7	12,446	0.396	4,929
			Suburban	2	670	0.509	341
	Dornan	1980	Commuter rail	9	37,356	1.237	46,215
New York	Walder	1981	Peak express	9	19,856	2.50	49,665
			Yukon Depot	6	15,150	2.50	37,874
			Castleton	3	4,716	2.50	11,791
	Dornan	1980	Commuter rail	Many	269,473	1.84	496,167
Washington, D.C.	Dornan	1980	Commuter rail	2	3,292	3.10	10,198
Pittsburgh	Dornan			2	1,868	1.03	1,929
Detroit	Dornan	1980	Commuter rail	1	2,070	1.00	2,070

should ideally be adjusted to compensate for any revenue loss that results from federally mandated fare reductions. Nevertheless, most of the variation in revenue per passenger within individual transit systems probably reflects the effects of the various fare discounts that a system voluntarily chooses to offer, rather than the effects of discounts it is required to provide. The most important of these are the substantial effective discounts most U.S. transit systems now offer to their regular riders—particularly to regular peak-hour commuters who are the most costly passengers to serve—in the form of weekly or monthly unlimited use passes that are typically priced well below the equivalent of one round trip per weekday. Substantial fare discounts for students, youth, and various other groups are also commonplace. For example, in St. Louis about 13 percent of riders are elderly, and over 20 percent are eligible for youth or student fares; in Philadelphia, elderly and student passengers represent 7 and 12 percent of total ridership, respectively. In cities such as Los Angeles and Seattle, these percentages are approximately reversed (*16*), but the total fraction of riders eligible for reduced fares is still almost 20 percent. Although some of these discounts serve laudable social purposes, others, particularly the discounting of weekly or monthly commuter passes, are not necessarily desirable from a social viewpoint, and entail substantial revenue losses to the large number of transit authorities that currently offer them.

ASSESSING THE "PROFITABILITY" OF TRANSIT SERVICES

Combined in Table 5 are the adjusted estimates of daily direct operating expenses for different types of service operated by various U.S. transit authorities, previously reported in Table 3, with the daily farebox revenue estimates from Table 4. This produces estimates of the average daily deficit that is directly attributable to each of 26 specific categories of service operated by transit authorities in eight of the nation's major urban areas. Also given in Table 5 is the equivalent deficit per passenger for each category of transit service, as well as the percentage of the services direct operating costs, which is covered by the passenger fare revenues generated.

The most striking finding from Table 5 is that none of the categories of transit service reviewed in this study produces farebox revenues sufficient to cover even the direct, day-to-day operating expenses incurred by the public authority that currently provides it. Most services cover far less than half of their direct expenses, as the right-hand column of the table indicates, thus producing per-passenger deficits that are most commonly within the $0.50 to $2.00 range, and reaching nearly $3.00 in several instances. The implication of these figures is unmistakable: even under the narrow, extremely conservative definition of transit costs employed in this study, there are apparently few if any examples of profitable service operated by the public authorities that now provide most U.S. urban transit services. Clearly, there is very little or no "cream to skim" from current public transit operations.

As reported in Table 5, commuter railroad and peak-period express bus service in New York City apparently come the closest to covering their direct operating expenses, but only at quite high average fares ($1.84 and $2.50, as reported in Table 4), and only under definitions of operating expenses that exclude large overhead outlays that are almost completely dedicated to the provision of these services. Aside from these two examples, only a handful of other services generate fare

TABLE 5 DEFICIT ESTIMATES FOR VARIOUS URBAN TRANSIT SERVICES

Urban Area	Type of Service	No. of Routes	Estimated Average Daily ($) Cost	Revenue	Deficit	Deficit/ Passenger ($)	Revenue as Percentage of Cost
Los Angeles	Peak express	14	61,900	22,800	39,100	0.94	36.8
	Intown	Many	330,600	191,400	139,200	0.16	57.9
	Suburban	Many	126,500	37,700	88,800	0.65	29.8
San Diego	Radial	3	12,811	3,403	9,408	0.95	26.6
	Peak		7,666	2,867	4,799	0.59	37.4
	Nonpeak		5,146	527	4,619	2.62	10.2
	Intown	2	6,276	3,873	2,403	0.21	61.7
	Suburban	5	8,890	1,834	7,056	1.33	20.6
San Francisco-Oakland	Peak express	3	10,985	1,573	9,412	2.03	14.3
	Radial	4	34,131	15,220	18,911	0.36	44.6
	Intown	3	6,914	1,033	5,881	1.65	14.9
	Suburban	5	11,715	953	10,762	3.27	8.1
	Rail feeder	5	8,507	2,201	6,306	1.91	25.9
	Commuter rail	1	46,928	24,533	22,395	1.10	52.3
Boston	Express	3	4,655	1,890	2,765	0.79	40.6
	Peak		2,970	1,454	1,516	0.56	49.0
	Nonpeak		1,685	436	1,249	1.54	25.9
	Radial	4	11,708	5,925	5,783	0.39	50.6
	Crosstown	7	11,151	4,929	6,222	0.50	44.2
	Suburban	2	1,030	341	689	1.03	33.1
	Commuter rail	9	132,739	46,215	86,542	2.32	34.8
New York	Peak express	9	51,858	49,665	2,193	0.11	95.8
	Commuter rail	Many	785,020	496,167	288,853	1.07	63.2
Washington, D.C.	Commuter rail	2	20,057	10,198	9,859	2.99	50.8
Pittsburgh	Commuter rail	2	10,657	1,929	8,728	4.67	18.1
Detroit	Commuter rail	1	7,528	2,070	5,456	2.64	27.5

Source: Computed from data reported in Tables 3 and 4.

revenues that cover even one-half of their narrowly defined operating expenses. As indicated in Table 5, farebox coverage ratios for the remaining services are about evenly distributed over the range from 10 to 50 percent, while per-passenger deficits are scattered widely over the range from about $0.20 up to nearly $3.00. (Because costs per passenger carried differ substantially among the categories of transit service studied, there is not necessarily a connection between the farebox coverage ratio and deficit per passenger for an individual service type, although a general relationship between the two is shown in Table 5.)

DIFFERENCES IN FAREBOX COVERAGE BY SERVICE TYPE

In Table 6 the typology of transit service given in Table 1 is combined with the estimates of farebox coverage of operating expenses reported in Table 5, in order to summarize variation in expense coverage by type of transit service. For each combination of transit route orientation and time period during which service operates, the range of farebox coverage ratios developed from the cost and revenue estimates constructed in this study, as reported in Table 5, are given (Table 6). Although almost every category of service for which multiple estimates are available shows a fairly wide range of variation in farebox coverage of expenses, the distribution of estimates within specific categories suggests some interesting patterns.

TABLE 6 FAREBOX REVENUE AS A PERCENTAGE OF DIRECT EXPENSES FOR VARIOUS TYPES OF URBAN TRANSIT SERVICE

	Time Period During Service Operation (%)		
Route Orientation	Weekday Peak	Other Hours[a]	All Hours
CBD-bound radial			
Express bus	14–96	26	41
Local bus	37	10	27–51
Commuter rail	18–51		35–63
Intown local			15–62
Suburban local			8–33
Crosstown or intersuburban			44
Rail-system feeder			26

Note: Direct operating and maintenance expenses plus use-related vehicle depreciation only. Includes no allowance for fixed facilities, managerial personnel, or administrative functions.

[a]Including weekday midday, night, weekend, and holiday service.

Source: Table 4 with figures rounded to nearest whole percent.

The most significant of these patterns shows that farebox coverage generally tends to be lowest for peak-period express, suburban local, and rail-station feeder services (some routes serve a combination of these last two functions), although farebox coverage tends to be highest for intown and crosstown local bus routes. Normal variation in the costs incurred in operating the different types of transit service reinforces this pattern of farebox coverage, thus producing the largest deficits per rider on peak express and suburban local service, and the smallest deficits per rider on intown services, with deficits on crosstown bus routes often falling in between.

Similar to the finding that there are apparently no profitable services currently operated by public transit authorities, the pattern of variation in farebox coverage ratios and deficits per passenger has an extremely important implication for federal policies aimed at promoting private participation in urban transit. The deficits now incurred by public transit authorities appear to be largest for exactly those types of service that private transportation suppliers have shown the most interest in assuming on a for-profit basis or in providing under contract to their current operators. This includes (*a*) peak-period express bus services, which charter and intercity bus operators already handle, both for profit and under contract to public agencies, in many of the nation's larger urban areas; (*b*) suburban local service, which is successfully provided on a demand-responsive basis by taxi companies and passenger van operators in some urban areas; and (*c*) rail-station feeder service, now provided in a few cities with large rapid transit systems by profit-seeking private passenger van owners who operate in spite of local regulatory restrictions.

SUMMARY

The research reported here demonstrates that there are apparently extremely few, if any, urban transit services now operated by public agencies in U.S. cities that generate farebox revenues sufficient to cover even their direct, day-to-day operating expenses. Most types of service provided by large public transit authorities now generate farebox revenues that cover less than one-half of their direct operating expenses, thus producing per-passenger deficits ranging from 50 cents to $3.00. Hence even under the extremely conservative definition of directly attributable costs used in this study, there seems to be very little, if any, "cream to skim" from current public transit operations.

More importantly, farebox coverage of operating expenses appears to be lowest (and deficits per passenger highest) for exactly those services in which private participants have exhibited the greatest interest. Thus there appears to be little risk that widespread contracting out of urban transit service will produce increased deficits for its current operators. Moreover, deficits appear to be largest exactly where the opportunities to reduce them through contracting out or other arrangements involving increased private participation are greatest.

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On-Time Performance and the Exponential Probability Distribution

WAYNE K. TALLEY AND A. JEFF BECKER

In spite of the seemingly strong support for research in on-time performance of bus service, previous research has largely been informal with little statistical basis. In this paper, it is concluded that the distribution of late and early time intervals between actual and scheduled time arrivals for buses at bus stops on a particular route conforms to the exponential probability distribution. The probability equation of the distribution can be used to compute the probability or percentage of buses arriving at a given bus stop that will be more than x minutes early or more than y minutes late. These probabilities may be interpreted as failure rates. The probability equation allows flexibility in interpreting results and setting standards for on-time performance.

The significant amounts of government funding being provided to public transit firms has given rise to concern regarding public return from such funding. This has led to an interest in studying the performance of public transit firms. Because bus service is the most common to be provided by public transit firms, particular attention has been given to studying its performance.

One area in the performance evaluation of bus service that has received a great deal of attention is on-time performance. On-time performance of bus service has been defined by John Bates (*1*) as "a motorbus passing or leaving a predetermined point along its routing within a time envelope that is no more than x minutes earlier and no more than y minutes later than a published schedule time." Recently, a survey (*1*) was conducted to determine basic practices and attitudes concerning on-time performance of bus service. The general conclusions of the survey are:

1. There is wide variation in the definition of on-time performance; however, a definition of no more than 1 min early and no more than 5 min late is the most commonly used.
2. Determination of on-time performance appears to be a largely informal practice with little statistical basis.

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