TRANSPORTATION RESEARCH RECORD 589

Urban Transportation Finance

TRANSPORTATION RESEARCH BOARD

COMMISSION ON SOCIOTECHNICAL SYSTEMS
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1976

Transportation Research Record 589
Price $2.20
Edited for TRB by Marjorie Moore

subject areas
15 transportation economics
81 urban transportation administration

Transportation Research Board publications are available by ordering directly from the board. They may also be obtained on a regular basis through organizational or individual supporting membership in the board; members or library subscribers are eligible for substantial discounts. For further information, write to the Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Notice

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competence and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The views expressed in this report are those of the authors and do not necessarily reflect the view of the committee, the Transportation Research Board, the National Academy of Sciences, or the sponsors of the project.

Library of Congress Cataloging in Publication Data
National Research Council. Transportation Research Board.
Urban transportation finance.

(Transportation research record; 589)
1. Urban transportation–United States–Finance–Addresses, essays, lectures. 2. Transportation planning–United States–Finance–Addresses, essays, lectures. I. Title. II. Series.
TE7.H5 no. 589 [HE308] 308.5'08s [388.4'042]
ISBN 0-309-02555-9 76-456071

Sponsorship of the Papers in This Transportation Research Record

GROUP 1–TRANSPORTATION SYSTEMS PLANNING AND ADMINISTRATION
E. Wilson Campbell, New York State Department of Transportation, chairman

Social, Economic, and Environmental Factors Section
Floyd I. Thiel, Federal Highway Administration, chairman

Committee on Taxation, Finance, and Pricing
Charles A. Hedges, U.S. Department of Transportation, chairman
Carmen Difiglio, Federal Energy Administration, secretary
Gary R. Allen, Alan Baughcum, Kiran Bhatt, Dwight M. Blood, J. Hayden Boyd, Richard P. Brief, Milton L. Brooks, R. L. Carstens, Peter S. Craig, Jose A. Gomez-Ibanez, Hatim M. Hajj, George W. Hilton, Joel L. Horowitz, Arnold H. Karvasarsky, Milan Krukar, Damian J. Kulash, Bruce D. McDowell, James P. Moody, Gabriel J. Roth, David G. Smith, Donald G. Symmes, William B. Tye, William S. Vickrey, George F. Wiggers, Martin Wohl

Public Transportation Section
Douglas F. Haist, Wisconsin Department of Transportation, chairman

Committee on Public Transportation Planning and Development
Kenneth W. Heathington, University of Tennessee, chairman
Daniel M. Brown, Robert C. Buchanan, John L. Crain, James P. Curry, Frank W. Davis, Jr., John W. Dickey, James C. Echols, William K. Fowler, George Edward Gray, David T. Hartgen, F. Norman Hill, William T. Howard, Eugene J. Lessieu, Lillian C. Liburdi, Stephen G. McConahey, B. Thomas Moore, William T. Olsen, Philip J. Ringo, Gilbert T. Satterly, Jr., George M. Smerk, Donald R. Spivack, Edward Weiner, John D. Wells

Kenneth E. Cook, Stephen E. Blake, and W. Campbell Graeub, Transportation Research Board staff

Sponsorship is indicated by a footnote on the first page of each report. The organizational units and the officers and members are as of December 31, 1975.

Contents

Redistributive Effects of Public Transit: Framework and Case Study

Steven M. Rock, University of Illinois at Chicago Circle

Study of the redistributive effects of public policy, i.e., who pays and who benefits, is often lacking in economic analysis. This paper stresses the importance of including a redistributive focus and presents a procedure for analyzing redistributive effects in public transit. The main redistributive effect studied is due to varying profitabilities of transit lines. Ceteris paribus, the users of profitable lines subsidize the users of unprofitable lines. To measure this effect requires that the costs and revenues of the transit system be allocated to the individual lines. The means of accomplishing this allocation are considered. The results can then be correlated with socioeconomic data of the users of each line. Along with this, variables that seem important in explaining the variance in line profitability can be tested. This framework is applied in a case study of the Chicago transit system.

The study of redistributive effects should be a part of any analysis of public policy. These effects are concerned with who pays for a particular program and who benefits. An obvious example of redistribution is the tax system. Taxes are collected by the government and in turn are spent on various public programs. However, those persons who pay taxes are generally not those who receive the benefits of the expenditure of their tax dollars. Thus, income may be redistributed from some identifiable groups to other identifiable groups.

A number of studies of these effects have already been undertaken; they generally deal with total government tax and expenditure figures, broken down by income class (5, 14). However, few attempts have been made to determine the redistributive effects of a single component of government activity; exceptions (1) include public higher education, water resource development, and the farm program. It is likely that any public program has redistributive effects. While this is the objective of a few programs (e.g., social security and welfare), most other programs are not specifically designed for redistribution. Nevertheless, these programs have distributional impacts.

Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

There are a number of reasons for studying redistributive effects. As Booms and Halldorson (2) suggest, these effects

> are an important determinant of the quality of life for many people in our society. The allocation of public burdens and benefits is a major point of conflict in our society. It is obviously advantageous to know something about the factors influencing the distribution of public outcomes.

Also, Hansen and Weisbrod (6) note that

> a knowledge of the magnitude and distribution of subsidies or direct benefits provided through ... any public program is important for what it suggests concerning appropriate pricing, tax and expenditure policies.

In the past, economic analysis has tended to concentrate solely on the efficiency of a project, i.e., the degree of success of an activity in producing outputs that are more valuable than the resources used in production. Most of these studies have completely ignored equity (i.e., distributive) effects. In this regard, Weisbrod (15) states:

> To date, valuation of distributional effects of public expenditure programs has eluded economists.... It is the exceptional... analysis that considers them explicitly. Indeed, according to a recent survey of the literature [11] ..., it almost seems wrong to consider distributional effects.

Decision makers, however, tend to base their choices on equity considerations as well as efficiency criteria. In theory, integrating distributional gains and losses with efficiency benefits and costs into a single grand efficiency measure would be optimal. However, this is not possible unless weights for different groups' benefits and costs can be devised. Even if equity effects cannot be quantified, it is still important to consider them along with efficiency results. To that end, this study is concerned with the issue of equity, rather than the issue of efficiency, in what is often a government program (public transit). A framework is presented to identify which groups receive the benefits of this public program and which groups pay the associated costs, i.e., the redistributive effects of public transit. Then this framework is applied in a case study of the redistributive effects of the Chicago rapid transit system.

A FRAMEWORK FOR ANALYSIS

Redistributive effects can occur between users and nonusers, particularly if a transit system runs a deficit. In addition, distributional effects are evident between users. Five specific user effects can be identified (12). One of these is due to fare reductions available to certain groups (13). Three other effects are caused by the interplay of the fare structure with uneven use patterns: peak versus off-peak redistribution, long-haul versus short-haul redistribution, and peak direction versus backhaul redistribution. A final effect is due to the differing costs and revenues of each transit line. This paper concentrates on the latter user effect.

The following procedure is proposed to determine the redistributive effects due to the differing costs and revenues of each line. First, the costs of the transit system must be determined and assigned to the users. To do this requires that the costs of operating each line under consideration be determined. This involves examining the various cost categories inherent in providing transit service and examining the allocation of these costs, by suitable bases, to the various line segments. Then, the revenues for each line should be obtained and matched with the costs for each section. This gives a measure of the redistribution involved between lines. Finally, to determine what identifiable groups of people are involved in redistribution, socioeconomic data such as the income levels and racial composition of the users of each line are necessary. In addition, the variables that seem important in explaining why the costs and revenues vary by line can be investigated.

Before the allocation of transit costs and revenues is undertaken, the relationships between these amounts and total benefits and costs need to be specified. With demand given, a transit company incurs the costs of setting up and operating a system and thus provides a level of service (Figure 1). From this service, users obtain direct benefits, and all people experience certain external benefits (e.g., reduced pollution and road congestion) and external costs (e.g., noise) from the existence of the system. Because of the nature of externalities, they cannot be recovered by the transit firm. Only some of the direct user benefits can be recovered from the market for transportation services. Because people will pay for a service only if it is worth no less than the price, their total direct benefits will reflect the sum of the price paid for the service (i.e., user cost, which becomes transit revenue) plus any consumers' surplus that is reaped. The transit firm is only interested in the amount of its costs and revenues. From a wider point of view (such as the community's), the value of external benefits and costs and consumers' surplus (8) should be considered in addition to the transit firm's costs and revenues. Because of the difficulty involved in putting a value on externalities and consumers' surplus, only direct costs and revenues can be considered. Therefore, the research must focus on the transit firm's perspective as expressed in its accounts. Nonetheless, to the extent that the users of the system contribute to costs and revenues, their focus will be included as well.

The demand for transit service (and lack of private supply) provides the rationale for an authority to set up and operate a system. Although this study is concerned with demand only as it directly affects costs and revenues, a brief word relating these concepts is appropriate. Lang and Soberman (7) suggest that rush-hour transit capacity requirements are obtained from peak demand and the car space per person that is allowed. In turn, this rush-hour capacity dictates equipment, work force, and energy needs. These factors largely determine operating costs (since provision for peak service will cover much of the capacity in labor, capital, and other factors needed to meet off-peak demand) and therefore unit costs as well. Unit costs, to the extent that they are reflected in fare levels, affect transit demand. Thus, the chain of cause and effect actually comes full circle.

Cost Allocation

The first step in determining redistributive effects is the measurement and allocation of the costs of transit operations to individual lines. Relevant cost allocation literature includes Lang and Soberman (7) and Morlok (9, 10). Although cost allocation is a fairly straightforward and mechanical procedure, care must be exercised.

A general principle in (variable) cost allocation is to express costs as a function of the output measure that reflects the reasons for incurring the cost. Depending on the cost category, an appropriate basis might be car-kilometers (for costs that vary with usage such as vehicle repair costs), track-kilometers (for costs that are time based and related to the length of track, e.g., some station and signal costs), or scheduled payroll hours (for costs that are labor related, e.g., cost of operators and ticket agents). This method of cost allocation is distinguished from three other methods. One method common in transportation planning literature expresses all operating costs as constant per car-kilometer. This method is quite crude, since only some costs are a function of car-kilometers. A second possibility is a cross-sectional regression analysis of the cost data of various transit systems. The difficulty with this approach is the small number of systems in existence. Also, this overlooks the peculiarities inherent in a particular transit firm's operating and accounting procedure. The third method uses the results of a time-series regression analysis of system costs. The lack of long time-series data, the small range of the variables, and the difficulty in applying this to a detailed examination of a system make this approach infeasible.

Additional cost-related considerations include the allocation of fixed costs, the distinction between the true and average cost curves, and the problem of measuring quality of service. Although it is reasonable to allocate variable costs as a function of the appropriate output measure, fixed costs (e.g., management and capital) cannot easily be handled in this manner. These fixed costs depend largely on the size of the transit firm's operation. Thus, Lang and Soberman (7) suggest that they might best be allocated as a fixed percentage of operating costs, inasmuch as fixed costs provide the base from which all operating costs develop. If this line of reasoning is followed, operating costs (in aggregate or broken down by line) would be increased by a percentage sufficient to account for an annualized amount of fixed costs. This assumes that fixed costs accrue to each line on the same basis as total operating costs. However, application of this procedure will not affect the relative costs of the lines (vis-à-vis each other). Because of this fact and the somewhat arbitrary nature of fixed-cost allocation, not considering these costs would not significantly affect a study of user redistributive effects.

When the variable costs of transit are allocated as a function of an output measure, it is desirable to know the true cost curve over the range of all outputs. The true cost curve in general will not coincide with the average cost curve because of economies of scale in provision of transit. Unfortunately, only total or average cost data are available. Thus, it must be assumed that costs vary linearly with the appropriate output measure. This limitation must be kept in mind, for it necessarily introduces some bias in any cost prediction or allocation that is made. A similar limitation relates to the quality of service on the system. This aspect will differ markedly throughout the system; for example, new equipment will require less maintenance than old. Because of the data available and the inability to quantify quality differences, service quality must be assumed to be uniform throughout the system.

Revenue Allocation

The allocation of system cost to each line must be matched with an allocation of system revenue. Three possible approaches for accomplishing this are considered: by originating revenue, by incremental revenue, and by adjusted originating revenue.

The first approach to revenue allocation is simply to note the amount collected on each line (originating revenue). The main advantage in using these data is that they are readily available. The disadvantage of this approach is that it fails to account properly for those trips that travel over more than one line if patrons pay their total fare (including transfer charges) when they start their trip. Regardless of where the trip is taken on the system, all of the fare paid is attributed to the originating line. Thus, if a trip begins on line 1 and ends on line 2, no revenue will be reported for line 2. This would be mitigated, of course, to the extent that trips taken are round trips. For example, as a complement to the above trip, the return trip begins on line 2 and ends on line 1. The originating revenue for this return trip will be credited to line 2. Depending on what the originating fare is on each line, there may be objections to the way the revenue is split between the two lines, but at least each line is credited with revenue. Another bias occurs if a trip is taken on more than two lines; if this is the case, no revenue will be recorded for the middle lines.

A second way of dealing with revenue allocation is through an incremental approach. The term incremental refers to the costs or revenues of the entire system that are due to the existence of a particular line. To obtain the incremental cost and incremental revenue of a line, one would determine what system costs would be saved and what system revenues would be lost if that unit were to cease operations. In effect, the entire system with the line is being compared to the remaining system without the line. One apparent advantage of this method is that this type of analysis can be used for efficiency-oriented decision making (such as whether a line should be shut down or what scope of operation should be undertaken by comparing the incremental cost and revenue of the line at each scope).

The incremental cost of a line is composed of all operating costs that can be saved if the line is shut down (this assumes a sufficient time span). It is probable that most management costs and capital depreciation will not be saved and therefore should not be included. Estimating incremental revenue depends on determining what percentage of riders of a line would use alternate modes if the line were discontinued and what percentage would continue to use the transit system by riding a different line. Unless these percentages can be obtained, the incremental approach is not feasible. Another disadvantage of this approach is that it is only applicable to those lines whose shutdown would not radically affect other lines.

A third approach, which can be applied to analyzing one segment of a bimodal operation (e.g., analyzing the rail portion of a rail and bus transit system), is to obtain adjusted (originating) revenue. This procedure is based on the fact that the costs and revenues of a line ultimately are derived from the passengers who use the line. This is so whether they originate on that line or a different line. To reflect this fact and to consider all lines on an equal basis require that the revenue for passengers who originate on another line be added to originating revenue to obtain adjusted revenue. For example, if only the rail system is being analyzed, revenue for those passengers who arrive at a particular rail line by bus will be input (at the rail fare times the number of bus originators) and added to originating rail line revenue. This will throw off the apparent profitability of rail vis-à-vis bus, but if a study is solely interested in rail travel, then only the relative profitability of rail lines is of interest. This approach more truly represents the ridership differences between the rail lines.

Of course, inputing all of the bus revenue for those who arrive by bus as if they originated on the rail system will certainly overstate the amount of revenue that should be transferred from bus to rail. That is, some revenue should theoretically be left with the bus. The result of this allocation is a bias; those rail lines with a higher percentage of bus arrivers will seem relatively more profitable than those with a lower percentage. However, in a practical sense, there are no available criteria for determining how much revenue to leave with the bus and how much to attribute to rail. In the case study below, this bias does not appear to be significant (and is certainly less than the bias that would occur if the adjustment for bus originators was omitted entirely) inasmuch as the costs and revenues obtained seem consistent with other measures of profitability (e.g., load factor). A remaining bias with this approach, as with the first approach, occurs when a trip is taken on more than one line. This cannot be corrected or accounted for, because of the vast combinations of possible trips and the difficulty in designing criteria to allocate revenue (and cost) over each trip.

Cost-Revenue Ratios and Redistribution

After the costs and revenues have been allocated by line, these amounts must be combined, and the specific groups involved in redistribution should be identified. Along with this, the factors that seem important in causing the ratios to vary can be determined.

Two ways of combining costs and revenues are considered. First, line revenue can be subtracted from line cost and expressed in per capita terms for comparison purposes. Obviously, the results of this method depend vitally on the number of users. This direct dependence on number of users can be avoided by using another approach that considers the number of passengers only as they are reflected in the relative magnitudes of costs and revenues of a line. This second method is to combine costs and revenues into a cost-revenue (C-R) ratio. With respect to an individual line, the lower the ratio is, the more profitable the line is.

Both methods, per capita differences and ratios, will illustrate the same outcome. However, the ratio is less sensitive to the number of users. Another reason that the use of a ratio is preferred is the similarity between C-R ratios and cost-benefit ratios, which are used extensively in economic decision making. Because the focus of this study is the differences between the lines, the C-R ratios should be normalized to reflect the relative ratios between the lines. That is, the overall system C-R ratio should be adjusted to 1.00 so that only user redistribution is measured. Dividing all the line figures by the amount necessary to obtain an overall ratio of 1 will normalize the figures, i.e., solely reflect the differences between the lines.

Given the costs (and capacity) of each line, the higher the revenue is, the more profitable the line will be. This reflects the importance of filling capacity to give the line a low C-R ratio. A measure relating capacity to revenue is the load factor of each line, which is the average number of passengers per car measured at an appropriate point for a suitable time period (e.g., 24 hours). The line load factor should correlate strongly and inversely with the C-R ratio; specifically, the greater the line load factor is, the lower the ratio will be.

Before considering why the ratios vary as they do, two points should be clarified. First, what is the relationship between the ratios and redistribution? Second, what is the link between the ratios of each line and the users of that line? The cost-revenue ratios tell which lines are profitable and which lines are money losers. For example, assume that there are two lines in a system: A and B. The overall system is breaking even, but line A is profitable (has a C-R ratio less than 1) and line B is not (has a C-R ratio greater than 1). As the system is set up, the surplus of line A subsidizes the deficit of line B. Apparently, there is a redistribution of income from line A to line B. But, in fact, redistribution is not really between lines; it is a phenomenon taking place between users of a line. To be strictly correct in identifying who is subsidized and who is providing this subsidy requires that the identity and circumstances of the users of each line be determined. With this information, judgments concerning both the outcomes of redistribution and corresponding policy decisions can be made.

Given the cost-revenue ratios by line, two questions emerge. First, can the direction of redistribution be correlated with any socioeconomic characteristics of the users? Second, why do the ratios vary between the lines (i.e., what causes this variance)? To answer these questions, appropriate hypotheses can be formulated and tested through the use of linear regression, where the cost-revenue ratio is the dependent variable. The independent variables will fall into five broad categories: geographic and physical attributes, price variables, competition-measuring variables, policy variables, and socioeconomic variables. Within each category, variables that may be important should be considered, and the direction of their effect should be hypothesized. (The specific variables tested in each category will depend on data availability and the peculiarities of the system being analyzed.) Then, this hypothesis can be statistically tested, either singly against the C-R ratios or in combination with other variables.

CASE STUDY

The above framework was applied to the Chicago transit system. Publicly operated transit in the Chicago area is provided by the Chicago Transit Authority (CTA) through both surface (bus) and rapid transit (rail) operations. For simplicity, only rail lines of the CTA were considered, and these were broken into units suitable for analysis. The time period used was calendar year 1972. A more detailed description of the case study is given elsewhere (12).

To undertake the cost allocation, CTA financial reports and supporting data were analyzed in detail. The main document used was the Operating Location Cost Report, which breaks down 11 variable cost categories into three portions: surface, rapid, and common-to-system costs. The rail costs are further divided among four lines; but for a more meaningful result, it was necessary to break these four major lines into 10 distinct segments. Where necessary, finer details of these costs were consulted to improve the accuracy of the allocation.

The amount of each cost category that was allocated to the rapid system was determined, and this was in turn allocated to the 10 lines on the basis of the most appropriate output measure, as described above. The results of these calculations are given in Table 1 and the first column of Table 2. Capital and management costs are not included, for the reasons suggested above.

To begin the revenue allocation, originating revenue by line was obtained from CTA records. As mentioned above, this should be adjusted by imputing revenue for those who arrive by bus to each line. CTA data on bus originators were used to adjust the revenue of each rail line (the adjustment factor ranged from 0 to 233 percent of originating revenue). This will more accurately measure ridership differences between the lines. However, the bias that occurs when a trip is taken on more than one line remains. The extent of this bias was determined by obtaining the percentage of trips that are taken on only one line. The higher this percentage is, the less the possible bias is. The percentage of riders who use only the originating line is as follows:

Line	Percent	Line	Percent
Evanston	58.8	Ryan	88.6
Skokie	10.8	Congress	83.5
North	82.5	Douglas	86.6
South	89.2	Milwaukee	89.5
Lake	89.7	Ravenswood	74.8

Seven of the lines have figures in the range of 80 to 90 percent, and an eighth is just slightly less. It is reasonable to suspect that most of the trips taken on these lines go to the central business district and return home on the same line. Many of the remaining trips involve only two lines, and, under a round trip assumption, revenue will be credited to each line.

Any substantial bias, therefore, would come from two suburban lines: Evanston and Skokie (the percentage of trips taken only on the two lines is 60 and 10 respectively). Trips on these two lines that are taken on other lines will include a portion on the North line. Because many of these trips terminate in the CBD as well, under a round trip assumption revenue would be recorded in a suburban line (Evanston or Skokie) and the North line for each round trip. However, the originating fare is much higher in each suburb than on the North line, while the portion of the total trip is significantly shorter in time and distance in each suburb than it is on the North line. To this extent, the revenues for Evanston and Skokie are apt to be overstated relative to costs. For the same reasons, the other lines have revenues somewhat understated, although the main understated line is North.

The results of the cost and revenue allocation, and their combination into a ratio, are given in Table 2. In analyzing these results, it is highly likely that the figures for Evanston and Skokie do run in the direction indicated (Skokie being profitable, Evanston being a money loser). This inference is lent support by the following CTA statement (4): "Expansion to follow population

Figure 1. Relationship between transit costs and benefits.

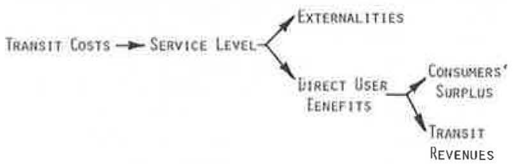


Table 1. Cost allocation for CTA rail rapid transit (1972).

Category	Amount (dollars)	Basis of Allocation
Trainmen	14 912 000	Scheduled payroll-hours
Agents, janitors, yardmen	15 832 000	Scheduled payroll-hours
Station operation	1 893 000	Car-kilometers
General office, utility, and traffic planning	2 753 000	Car-kilometers
Instruction, security	927 000	Car-kilometers
Shops and equipment	11 759 000	Car-kilometers
Engineering	6 407 000	Car-kilometers, track-kilometers
Electrical	4 741 000	Car-kilometers, track-kilometers
Power	3 970 000	Car-kilometers, track-kilometers
Snow and refuse removal	231 000	Track-kilometers
Provision for injuries and damages	634 000	Car-kilometers
Total	64 060 000	

Table 2. Results of cost and revenue allocation.

Line	Cost of Operation (dollars)	Adjusted Originating Revenue (dollars)	C/R	Normalized C/R
Evanston	2 977 000	2 460 000	1.21	1.32
Skokie	619 000	832 000	0.74	0.81
North	12 349 000	15 213 000	0.81	0.89
South	10 836 000	10 893 000	0.99	1.09
Ravenswood	5 536 000	4 774 000	1.16	1.27
Lake	6 189 000	5 889 000	1.05	1.15
Ryan	7 431 000	11 089 000	0.67	0.73
Congress	5 232 000	4 528 000	1.16	1.26
Douglas	4 667 000	5 314 000	0.88	0.96
Milwaukee	8 224 000	9 078 000	0.91	0.99
Total	64 060 000	70 071 000	0.91	1.00

Table 3. Results of simple linear regressions of cost-revenue ratios on listed variables.

Variable	Units	Hypothesized Direction	Regression Coefficient	Standard Error
Geographic				
North dummy	0, 1	?	+0.017 8	0.136 5
West dummy	0, 1	?	+0.109 7	0.144 0
South dummy	0, 1	?	-0.171 8	0.159 7
Expressway dummy	0, 1	?	-0.074 3	0.146 8
New line dummy	0, 1	-	-0.288 6[a]	0.108 7
Price				
Extra fare dummy	0, 1	+	+0.149 6	0.129 1
Average price	Cents/km	+	+0.129 4	0.172 6
Competitive				
Commuter railroad	Percentage of stations having this alternative	+	+0.002 5	0.002 4
Another CTA line	Percentage of stations having this alternative	+	+0.002 3	0.003 4
Policy				
24-hour agents	Percentage of stations	?	-0.002 2[b]	0.001 3
Stations per 1.6 km		?	+0.253 6[c]	0.085 4
Headway	Min	?	+0.069 2	0.076 4
New car dummy	0, 1	-	-0.056 7	0.135 2
Socioeconomic				
Density	Population/2.59 km^2	-	+0.000 001	0.000 011
Automobiles per capita		+	-0.080 3	0.804 5
User income	Dollars	?	-0.000 02	0.000 03
White income	Dollars	?	-0.000 03	0.000 04
Black income	Dollars	?	-0.000 03	0.000 02
Black users	Percentage	?	-0.002 6	0.003 1
Employed users	Percentage	-	-0.309 3	1.102 1

Note: 1 km = 0.6 mile; 1 km^2 = 0.4 $mile^2$.

[a]95% confidence level. [b]80% confidence level. [c]98% confidence level.

growth could not be accomplished 'from the fare-box' with the significant . . . exception of the Skokie Swift." Additional support for the contention appeared in mid-1973, when the CTA proposed closing a number of stations on the Evanston line. Although this proposal was later abandoned, the Evanston City Council Transportation Committee at the time felt that the closures had the objective of restructuring the Evanston service to an operation similar to Skokie's. Lending additional weight to the results is the fact that many Evanston patrons are within walking distance of the Chicago and Northwestern commuter railroad, alternatives that Skokie patrons do not have.

However, the results of a study by Wohl (16) seem at odds with these results. Wohl reported that during the first 2 years of operation of the Skokie Swift (1964-65) the total costs, including interest on capital outlays, exceeded revenue by \$485 000 or about 14 cents per trip. It is evident that in this study certain capital expenditures involved in setting up the Skokie service were included in the cost figures for these 2 years (e.g., line rehabilitation and parking lot construction). However, these capital items have a significantly greater life span than 2 years; thus, this procedure will overstate expenses. Additionally, one should question the full inclusion of one-time expenses (promotion and data survey costs). The correct amount to report will depend on the capital items considered (for example, does the purchase price of already owned equipment become an obligation of the Skokie line?), the capital recovery method and interest rate used, and the treatment of one-time expenses. In any case, Wohl's cost data are overstated. In fact, the publication from which the data on the Skokie line were obtained directly contradicts Wohl's results (3): "Skokie Swift has proven that fares collected could meet all the costs of operation."

As another check on the C-R ratios, the correlation between the load factor (obtained from CTA data at the maximum load point of each line for a 24-hour period in both directions) and the ratios was calculated. In confirmation of the hypothesis above, the simple correlation coefficient was -0.84. Thus, the C-R ratios are reasonably accurate.

The final step in the case study is to determine whether particular groups that are involved in redistribution can be identified and to determine what variables are significant in explaining the variance in the ratios. Many factors interact in determining the C-R ratios of the lines. Because of the small number of observations and degrees of freedom (10 lines), it is difficult to sort out all the influencing factors. For this reason, the statistical technique used seeks simply those variables that correlate best with the ratios. Thus for the most part, the analysis is limited to simple linear regression using a t-test as a measure of significance.

There are five categories of variables considered. The first category, geographical and physical attributes, contains variables that measure possible political favoring of different city areas, differences in geographic terrains, differences of costs and revenues owing to the type of right-of-way (e.g., location of line in the median of an expressway), and "newness" of lines. The second category, price, is difficult to represent because the base price of an originating trip was the same on all lines (with some minor exceptions). To work around this, variables accounting for the extra fare on some lines and average trip price were tested. The third category reflects the availability of competing services (for simplicity, the price of competing services was not considered). The nearness of commuter lines or other CTA lines to each line was measured. Fourth, variables were tested whose values are significantly determined by CTA policy decisions: percentage of stations with 24-hour agents, stations per 1.6 km (1 mile), train headway, and newness of cars. The final category of variables considered is socioeconomic influences. These include density around the lines, automobiles per capita around the lines, user income, race of users, and percentage employed living near a line.

The results of simple linear regression of the above variables on the C-R ratios are given in Table 3, along with the hypothesized directions for each variable. The most significant single variable explaining the ratios is stations per 1.6 km (1 mile). The positive correlation suggests that more stations mean less net revenue (a lower C-R ratio); thus, a faster train seems preferred to more access, or costs are lower with fewer stations. A number of variables that would be expected to be significant were not (e.g., density and automobiles per capita) because of the interaction of other variables, the small sample size, and incomplete specification, among other reasons.

The lack of significance of the race and income variables suggests that no identifiable redistribution by income or race is taking place. Nevertheless, a simple redistribution does occur between users of each line. Skokie, North, and Ryan users are subsidizing Evanston, Ravenswood, Lake, and Congress users, but the users of other lines are not involved in redistribution.

CONCLUSION

A framework for analyzing the redistributive effect due to the differing costs and revenues of transit lines was presented. This consists of an allocation of system costs to each line or segment. This is complemented by an allocation of system revenue to each line. The resulting costs and revenues can be combined and statistically tested to determine what variables are important in causing these figures to vary and whether identifiable groups are involved in redistribution.

A case study using the Chicago rail rapid transit system was presented to illustrate use of the framework. The most important single variable explaining the variance of costs and revenues is stations per 1.6 km (1 mile). Surprisingly, variables measuring density and automobiles per capita tested insignificant. Similarly, no conclusions on the direction of redistribution between identifiable groups could be made. This lack of significant results is probably due to small sample size, data limitations, and the compound influence of many variables. The resulting redistribution is simply from users of the profitable lines to users of the unprofitable lines.

This suggests that the redistributive framework presented may be most fruitfully applied to an area smaller than Chicago, where the number of lines, trip possibilities, influencing variables, and resulting data needs will be much less. In addition, other forms of redistribution need to be investigated, both among users (e.g., reduced fare policies, peak versus off-peak policies, long-haul versus short-haul pricing) and between users and nonusers (e.g., financing of a transit system deficit).

ACKNOWLEDGMENTS

A portion of the data used in the case study was provided by the Chicago Transit Authority and the Chicago Area Transportation Study. The research was supported in part by a grant from the National Science Foundation. The author wishes to thank Walter Fisher, Philip Eisenstat, Andrew Daughety, Martin Wohl, and others for their helpful comments and suggestions.

REFERENCES

1. J. T. Bonnen. The Absence of Knowledge of Distributional Impacts: An Obstacle to Effective Policy Analysis and Decisions. In Public Expenditures and Policy Analysis (R. H. Haveman and J. Margolis, eds.), Markham Publishing Co., Chicago, 1970.
2. B. H. Booms and J. R. Halldorson. The Politics of Redistribution: A Reformulation. American Political Science Review, Vol. 67, 1973, pp. 924-933.
3. Skokie Swift: The Commuter's Friend. Chicago Transit Authority, Publ. RP-X68222, May 1968.
4. Transit in Chicago: A Metropolitan Area Public Service. Chicago Transit Authority, Publ. RP-X71147, May 1972.
5. W. I. Gillespie. The Effect of Public Expenditures on the Distribution of Income. In Essays in Fiscal Federalism (R. A. Musgrave, ed.), Brookings Institution, Washington, D.C., 1965.
6. W. L. Hansen and B. A. Weisbrod. Benefits, Costs and Finance of Public Higher Education. Markham Publishing Co., Chicago, 1969.
7. A. S. Lang and R. A. Soberman. Urban Rail Transit: Its Economics and Technology. MIT Press, Cambridge, 1964.
8. E. J. Mishan. Economics for Social Decisions: Elements of Cost-Benefit Analysis. Praeger, New York, 1972.
9. E. Morlok. Rail Transit Costs. Transportation

Center, Northwestern Univ., Evanston, Ill., 1965.
10. E. Morlok, W. M. Kulash, and H. L. Vandersypen. The Effect of Reduced Fare Plans for the Elerly on Transit System Routes. Transportation Center, Northwestern Univ., Evanston, Ill., 1971.
11. A. R. Prest and R. Turvey. Cost-Benefit Analysis: A Survey. Economic Journal, Vol. 75, Dec. 1965, pp. 683-735.
12. S. M. Rock. The Redistributive Effects of Mass Transit in the Chicago Area. Northwestern Univ., Evanston, Ill., PhD dissertation, 1975.
13. S. M. Rock. The Redistributive Effects of Reduced Transit Fares for Particular Groups. Univ. of Illinois at Chicago Circle, 1975.
14. Tax Burdens and Benefits of Government Expenditures by Income Class, 1961 and 1965. Tax Foundation, Inc., New York, 1967.
15. B. A. Weisbrod. Income Redistribution Effects and Benefit-Cost Analysis. In Problems in Public Expenditure Analysis (S. B. Chase, ed.), Brookings Institution, Washington, D.C., 1968.
16. M. Wohl. Users of Urban Transportation and Their Income Circumstances. Traffic Quarterly, Vol. 24, Jan. 1970, pp. 21-43.

Cost-Oriented Methodology for Short-Range Transportation Planning

Douglass B. Lee, Jr., Center for Urban Transportation Studies, University of Iowa

A transportation planning methodology is proposed that is more adaptable and responsive to short-range issues than is the existing transportation planning process, which was designed as a long-range methodology. The suggested planning process (a) approaches conclusions in an iterative manner, (b) has flexibility in the ordering of steps in the procedure, and (c) requires fewer data. Although demand analysis constitutes a key component in the methodology, emphasis is on a comparative cost impact evaluation framework, in contrast to a demand forecasting approach. The I-66/Metro corridor near Washington, D.C., is used to illustrate one cycle of the analysis.

Transportation planners are currently struggling with a methodology developed for long-range planning and not easily adapted to short-range planning problems. A primary difficulty seems to be the inherent linearity of the methodology, although attempts have been made to incorporate feedback lines into the analysis. Compounding this with the concept of comprehensiveness (5) results in a process that is cumbersome, awkward, and unreliable in addressing the specific issues of short-range planning.

The strategy presented attempts to strike a balance among several objectives: the need to handle complex interactions, the desirability of a methodology that can be disaggregated piecemeal to suit the particular application, the need to improve communication between the technical and political components of the planning process, and the desirability of streamlining transportation planning analysis as well as reducing its cost. More particularly, the methodology is (a) iterative in that it approaches a solution by cycling and recycling over the major components, (b) flexible in that the ordering of steps is not predetermined, and (c) parsimonious in that it uses the least amount of data that will support a policy decision.

Although some previous efforts (8, 11, 27, 29) have applied nonstandard approaches to the analysis of transportation issues, an alternative synthetic framework has not been developed. Mechanics of the methodology described below are illustrated by using the I-66/Metro corridor in northern Virginia.

FACTS, TARGETS, AND REQUIREMENTS OF THE IMPACT EVALUATION FRAMEWORK

A short-range impact evaluation framework is shown in Figure 1. Input parameters include base wage rates, purchase price of vehicle, fuel prices, and construction costs; service environment factors are the conditions affecting wear and tear and characteristics of the population served. Demand, service quality, pricing, and capacity are the major areas that may require iteration and are, for the most part, variables controlled or influenced by the public sector. A wide variety of unit costs including total deficits, deficit per passenger carried, trip cost per passenger, external costs, and long-run average cost provide the primary basis for evaluation. Travel time for the user can be entered as a cost or as a measure of quality.

Operationally, the analyst begins by listing salient facts (e.g., capacity of existing road network, price of gasoline) and adds a list of targets (minimum levels of service, desired modal split, maximum cost per trip, given vehicle capacity) until enough information has been assembled to calculate requirements (additional capital investment, occupancy factors, feeder systems, levels of operation). Any of these may be reordered, either between different problems or within different cycles of the same problem. Modal split, for example, can be regarded as fact, target, or requirement; the price of gasoline may be a fact today but a policy variable tomorrow.

Unit Costs

Under the proposed methodology, unit costs are the primary evaluation measure. This means not that benefits are ignored or that cost minimization is the decision criterion but that evaluation falls into one of the two following types:

1. For a given level and quality of service, costs

Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

should be minimized. This is a form of cost-effectiveness analysis, in that minimum costs for various levels of service can be compared and evaluated.

2. Benefits are evaluated in terms other than monetary units. Travel time savings, pollution reduction, energy savings, and reduction of waiting time can be quantified to whatever degree seems reasonable, but it is not necessary to force a dollar value on the results. If a good estimate of social value is readily available, of course it should be used.

This decision criterion, then, weighs social costs against a list of benefits, many of which are quantified and some of which are priced. The technical analyst can often make strong recommendations based on findings and expert judgment, but in most instances the decision is a political one; the planner should not attempt to subvert that process by providing a technical conclusion.

Choice of the most suitable unit cost is a difficult one, and often several will be needed from the multiplicity available. Figure 2 shows that possible unit costs range from cost per passenger-kilometer to costs per year. Not shown in Figure 2 are the various groups for whom a cost figure may be of interest: users, general taxpayers, transportation authorities and commissions, local and federal governments, and so on. There is no a priori best unit cost measure and no definitive list of impacted groups; at some point, however, it will be necessary in each problem situation to determine units and groups of interest, since the analysis has to be constructed with those in mind.

Input Parameters

None of the variables under consideration in the proposed methodology is purely exogenous, i.e., independent, but those listed under input parameters are the closest to being "facts." Items such as the base wage rate, vehicle lifetimes, and energy prices may vary by locality, while items such as vehicle cost, gasoline consumption rate, discount rate, and vehicle capacity (9) may pertain to the United States generally.

These basic input parameters were used in a sizable amount of literature on the construction of simplified cost functions (1, 2, 3, 6, 7, 10, 12-26, 28). Items such as construction cost per lane-kilometer, labor-hours per vehicle-hour in service, and vehicle-kilometers (or hours) per year per vehicle have been found to be stable enough or to vary systematically enough to provide useful rules of thumb. Techniques of statistical estimation, budget allocation, and theoretical relationships have been used to construct cost functions.

Service Environment

Attributes of the environment in which the transportation service must operate affect both the demand and the quality of service, for a given input of resources. From the other perspective, a difficult set of operating conditions—congested streets, harsh climate, incompatible user groups, high crime areas—will increase the cost of providing a given level and quality of service. Very little structural understanding of these interrelationships seems to have appeared, and the subject area constitutes an unfortunate research gap.

Demand

Constructing a complete demand function, or schedule, for all types of service, price combinations, location patterns, and the like is an extremely difficult task empirically and would be about as empty an exercise as is forecasting detailed land uses 20 years in the future. Most of the detail is not needed for planning purposes anyway.

So we are left making point estimates of future travel demand. These estimates can be greatly improved, however, if it is recognized, particularly in the short run, that price and service elasticities are valuable analytic tools, even if correct or even good pricing is not followed. Many problem situations require that alternative service levels and user charges be compared, and demand estimates should be responsive to these choices.

Capacity and Use

A given set of available resources (labor, rolling stock, right-of-way, materials, management) represents a capacity to offer service, which can be translated into vehicle-hours, vehicle-kilometers, peak seat capacity, or other measure of intermediate output. With a certain number of drivers and buses, for example, some number of bus-hours of service per day can be provided. The speed of this service then depends on the type of terrain, quality of the streets, congestion, number of stops per kilometer, and number of passengers per stop, among other things. Vehicle use is a function of peaking conditions and the amount of deadheading that is acceptable, while average occupancy is a function of available capacity and service demand.

Service Quality and Pricing

Based on the operating environment and the available capacity, actual characteristics of the service provided can be estimated. The user is not interested in the number of vehicles in service, the amount of congestion, the hilliness of the terrain, or the speed of the vehicle, except insofar as these determine the travel time, comfort, security, and other qualities that affect choice of trip, mode, and time. Service quality is the aspect of the supply side of the equation that interacts with the demand side, to set an equilibrium. Pricing, in this context, is limited to the impact of user changes on service consumption.

Standard mode choice analysis starts with a list of service quality characteristics for each mode and allocates to each mode a share of total demand. For some situations it may be more desirable to approach the question from the standpoint of what modal split would be necessary to achieve target occupancy and cost levels and what manipulation of service characteristics will be necessary to achieve that modal split. The object is to be able to do it both ways.

AN EXAMPLE: I-66/METRO CORRIDOR

The study corridor lies in northern Virginia in the Arlington, Falls Church, and Fairfax County suburbs of Washington, D.C. (Figure 3). Two major corridors, I-66 and Va-7, almost come together at I-495, the Capital Beltway; the remaining 16 km (10 miles) or so of the corridor into the District currently rely on a number of arterial highways. A summary of a first-cycle analysis is presented below.

Service Environment

Washington is a strongly core-dominated metropolitan area, and the I-66 corridor is one of several suburban commutersheds for the District. Arlington contains some apartment buildings, but the general pattern is one of single-family, townhouse, and other moderate- to low-density residential development: Population density declines from about 4600 persons/km^2 (12 000 persons/mile^2) at the inner end to about 1500 (4000) at a distance of 9.4 km (15 miles) out.

Demolition and relocation are not major problems inasmuch as most of the right-of-way was acquired some time ago. Currently, I-66 runs from the western edge of Fairfax County to the Beltway, so the traffic in the corridor is primarily commuter (not intercity or freight) vehicles. A profile of existing traffic during peak periods shows that the volume at the Beltway is slightly greater than that crossing the Potomac; in between, volume, which is siphoned off to office concentrations in Arlington, reaches a maximum. Hence, the Beltway is taken as controlling, for design purposes.

Input Parameters

Cost and capacity factors to be used for planning are given in Table 1, in their most natural units. For comparisons to be valid, costs must be stated in constant dollars (1975, in this case) and must be translated to a common unit of time.

Demand

Based on local estimates (4) of suburban development in the Va-7 and I-66 corridors outside the Beltway, 1985 peak-hour one-way trips at the screenline will be 45 000 persons (Table 2). The volume at present is 17 600 on a network that can carry about 9000 vehicles in the peak hour.

The estimate of future trips is subject to considerable error (no matter how precise or sophisticated the method) and is also influenced by public policy. Given the short-range framework applied here, it is assumed that

1. Impacts of changing land use patterns will be small on the aggregate forecast and
2. Total daily person-trips for work purposes will not be strongly affected by supply variables or pricing (instead, these variables will influence time of travel, mode, and occupancy).

Although the probable impacts of alternative land use patterns and supply side variables will certainly be substantial, they are less than the error inherent in the aggregate forecast itself.

Capacity

In the example, the major choices are the peak capacity to be provided on transportation facilities and the balance between modes. Only the line-haul system is considered explicitly, and the problem of how to accommodate a large number of additional vehicles in downtown Washington is shunted aside. The intent of this strategy is to restrict the analysis of downtown distribution problems to those alternatives that look good from a line-haul perspective.

Alternatives

1. Freeway. All additional trips are carried by automobiles, at 1.4 persons/vehicle. If we assume 2000 vehicles/hour/lane, 11.6 additional lanes of freeway would be required in the peak direction.
2. Metro. A surface rail rapid transit extension is used to full seated capacity, and additional trips are carried on buses. The excess demand left by a two-track Metro line will require about 160 buses loaded at 100 percent of seated capacity. In addition, transfer facilities from other modes to Metro would have to be developed.
3. Bus on busway. Same as alternative 2 but with a busway substituting for the rail line.
4. High occupancy. If no additions are made to the physical capacity of the network, the total number of peak trips can still be accommodated by increasing average vehicle occupancy. If we assume that automobile occupancy averages 3.0, vans average 8.0, and buses average 50 passengers at the Beltway and also that vans and buses are mixed equally in number, then 346 each of buses and vans would be needed. The remaining 8308 vehicles would be automobiles.

Not considered in these alternatives are possibilities of reducing the total number of trips, reducing the number of peak-hour trips by spreading the peak, using smaller vehicles, or developing systems not currently in general use in the United States. If all of the four alternatives prove unacceptable, then other alternatives might be sought; combinations of the above alternatives can be constructed once it has been determined which ones to emphasize.

Quality and Pricing

As a target, the objective is to maintain or improve existing levels of door-to-door service. What this objective means in practice and in detail will have to wait for a subsequent cycle in the analysis. It is assumed that each line-haul service would be adequately supported by feeder collection and distribution systems so as to achieve the mode splits given in Table 3. This assumption is not neutral between modes, of course; CBD distribution, for example, is much better on a subway system, while other core work trips can best be handled by express bus.

The central question of quality in the I-66 example is how and whether different travel patterns and modal splits can and will be achieved such that individuals will be provided a range of choices. Pricing incentives (e.g., monthly passes) and disincentives (e.g., elimination of free parking downtown) as well as physical constraints (car pooling and bus lanes that are adequately policed) can accomplish a great deal but may, at the same time, generate strong opposing pressures. Because these issues depend to a large extent on where the political will and the political muscle are located, analysis can only provide the options, not the answers.

Unit Costs

Because of the way the I-66 example has been constructed, both total trips and trip quality are assumed constant between one alternative and another; hence, user benefits and the effectiveness of each alternative are the same. Although this need not be the case, in the example the evaluation criterion becomes simply cost minimization.

All incremental capital and operating costs are included. Sunk costs in existing rights-of-way and vehicles are not included because they do not differ from one alternative to another; e.g., there are no recoverable costs (for our purposes) embedded in the existing arterial system. Many cost measures would suffice for comparison, but dollars per passenger-kilometer are given in Table 4. Because the trip is 16 km (10 miles) one way and the commuter year is assumed to have 250 days, trip cost (one way and daily round trip) and total cost per day, per commuter, and per year can be easily calculated.

The entire burden of incremental costs is assumed to

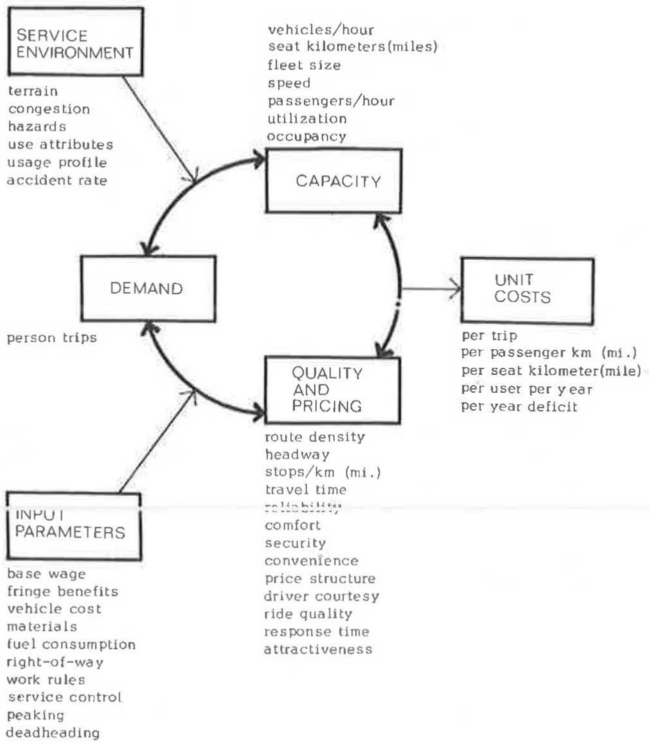


Figure 1. Short-range planning framework.

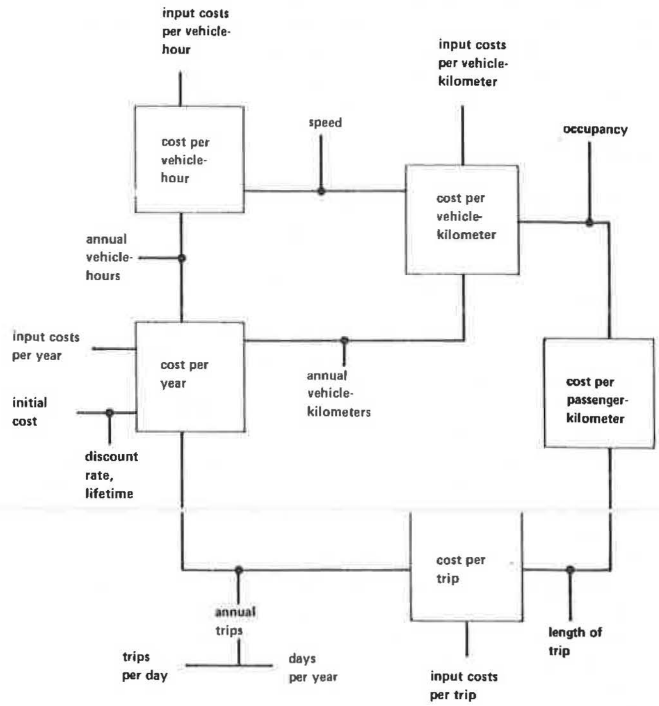


Figure 2. Generalized cost relationships.

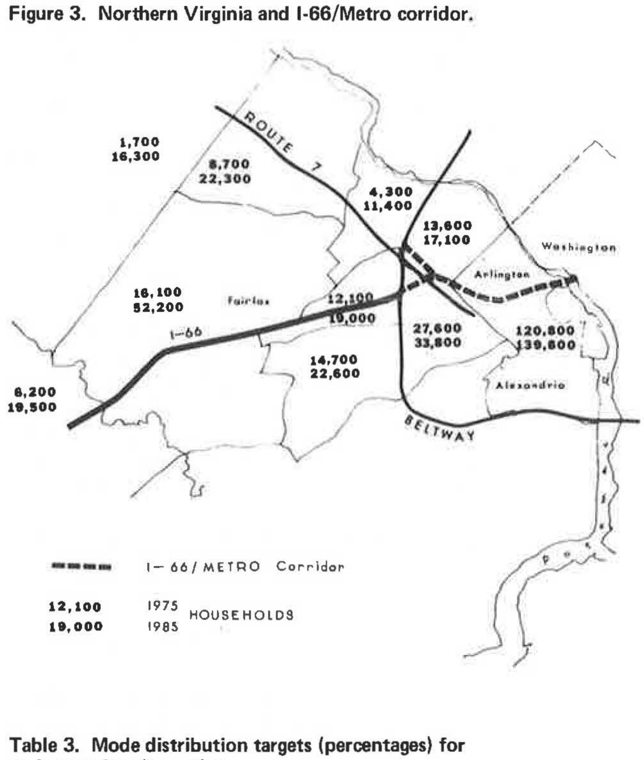


Figure 3. Northern Virginia and I-66/Metro corridor.

Table 1. Cost and capacity parameters for urban-suburban transportation modes.

Item	Cost (dollars)	Capacity
Six-lane freeway	2 600 000/km/year	6000 vehicles/hour
Automobile and vehicle operating	0.17/vehicle-km	4 to 6 passengers/vehicle
Bus operating	20/vehicle-hour	50 seats/bus
Bus vehicle	8000/vehicle/year	50 seats/bus
Busway	620 000/km/year	500 buses/hour
Rail rapid construction	1 000 000/km/year	300 vehicles/hour
Rail vehicle	33 000/vehicle/year	81 seats/vehicle
Rail rapid operating	80/vehicle-hour	81 seats/vehicle

Note: $1/km = $0.62/mile.

Table 2. Demand forecast.

Item	1975	1985
Households within corridor and outside Beltway	63 800	163 300
Vehicle trips by automobile	10 800	
Person trips by automobile	15 100	
Occupancy	1.4	
Person trips by transit	2500	
Person trips per household[a]	0.276	0.276
Total person trips	17 600	45 050

[a]Person trips for all purposes in the a.m. peak direction at the Beltway, as a ratio to households within zones outside the Beltway and encompassed by the I-66/Va-7 commutershed.

Table 3. Mode distribution targets (percentages) for each capacity alternative.

Alternative	Automobile	Bus	Rail	Total
Freeway	97	3		100
Rail	32	14	54	100
Busway	32	68		100
High occupancy	55	45		100

Table 4. Costs per passenger-kilometer for corridor alternatives.

Alternative	Cost (dollars)	Mode
Freeway	0.73	Automobile
Rail	0.20	Rail rapid transit
Busway	0.09	Bus on busway
High occupancy	0.08	Car pool on existing arterials
	0.06	Van pool on existing arterials
	0.04	Bus on existing arterials

Note: $1/passenger-km = $0.62/passenger-mile.

fall on peak-hour travelers. Although that is an extreme position, it is approximately accurate for the urban passenger transportation context. Even if some of the increased capacity were needed for other than peak-hour users, only a small share (10 or 20 percent) of the incremental costs might be assigned to other users.

CONCLUSIONS

Results of the first cycle of analysis led to some preliminary evaluations of the four alternatives proposed.

Alternative 1. In all respects current occupancy levels of the automobile make it an acceptable solution to the peak commuter problem. Besides the excessive cost, this alternative would substantially increase air and noise pollution, consume inordinate amounts of land, and generate enormous difficulties for the District in handling the volume of automobiles.

Alternative 2. The Metro rail alternative (supplemented by bus) is feasible from the cost-benefit standpoint, but the high mode choice requirement is probably not realizable in the short run without greater concentrations of activity around transit stations.

Alternative 3. A busway permits either integrated express service in the peak or line-haul feeder service with transfers. It has some of the disadvantages of the automobile, in that large numbers of buses would create air and noise pollution and place heavy demands on downtown Washington streets during the peak.

Alternative 4. As expected, the high-occupancy alternative is both low cost (even with an allowance for additional travel time) and low capital, in that major additional facilities would not be needed. There is, however, no democratic way to achieve it other than to charge very high user rates on automobiles and to severely restrict parking in the core area.

Although none of the alternatives appears acceptable, they suggest some combinations and reformulations that might be workable.

1. With the high-capacity, environmentally sound downtown distribution system of Metro already in place, this element ought to figure prominently in any solution to the I-66 corridor. The question is then whether to create a transfer point at Glebe Road in Arlington (where the system ends now) or to extend the line to Vienna (as planned). Other terminal stations (Tyson's Corner, west Falls Church) might also be compared.
2. Metro's downtown distribution system needs to be complemented with a system better suited to somewhat dispersed destinations, such as express bus or car or van pool systems. A joint rail-busway facility might provide sufficient benefits to justify the modest excess capacity.
3. Distribution of costs between users and general taxpayers should be tabulated, inasmuch as the user share seems to be declining on all modes.

The next cycle, obviously, will address a somewhat different set of problems and will lead to a third cycle, a fourth, and so on. One virtue of an iterative procedure is that it allows politicians, planning agencies, informed citizens, and the like to follow an issue to its resolution and provide feedback to keep the planning process on the right track. There does not seem to be another way to successfully address the complex problems we face in transportation planning.

ACKNOWLEDGMENTS

The author wishes to express thanks to Charles Hedges for encouragement and suggestions; to the TRB committee people who read the long original paper carefully and offered many constructive comments; and to Bill Tye and Hayden Boyd for their perceptive and helpful criticisms at the TRB meetings. The work was partially supported by a program of Research and Training in Urban Transportation sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation. The results and views expressed are the independent products of university research and are not necessarily concurred with by the Urban Mass Transportation Administration.

REFERENCES

1. K. Bhatt. A Comparative Analysis of Urban Transportation Costs. Urban Institute, Washington, D.C., Working Paper 5002-5, Jan. 1975.
2. H. Boyd et al. Evaluation of Rail Rapid Transit and Express Bus Service in the Urban Commuter Market. Institute for Defense Analyses, Arlington, Va., Oct. 1973.
3. D. Curry and D. Anderson. Procedures for Estimating Highway User Costs, Air Pollution, and Noise Effects. NCHRP, Rept. 133, 1972.
4. Preliminary Countywide Plan. Office of Comprehensive Planning, Fairfax County, Va., June 1975.
5. Urban Transportation Planning. Federal Highway Administration, U.S. Department of Transportation, Policy and Procedure Memorandum 50-9, Nov. 24, 1969.
6. P. Fisher and P. Viton. The Full Costs of Urban Transport, Part I: Preliminary Intermodal Cost Comparisons and Policy Implications. Institute of Urban and Regional Development, Univ. of California, Berkeley, Monograph 19, 1974.
7. F. Frye. Alternative Multimodal Passenger Transportation Systems. NCHRP, Rept. 146, 1973.
8. C. Hedges. An Evaluation of Commuter Transportation Alternatives. HRB, Highway Research Record 296, 1969.
9. Highway Capacity Manual—1965. HRB, Special Rept. 87, 1965.
10. Keeler, Theodore, Small, Kenneth, and Associates. The Full Costs of Urban Transport, Part III: Automobile Costs and Final Intermodal Cost Comparisons. Institute of Urban and Regional Development, Univ. of California, Berkeley, Monograph 21, 1975.
11. R. Kirby et al. Para Transit: Neglected Options for Urban Mobility. Urban Institute, Washington, D.C., 1975.
12. D. Lee. Costs of Urban and Suburban Passenger Transportation Modes. Institute of Urban and Regional Research, Univ. of Iowa, Working Paper 14, 1975.
13. D. Lee. Cost Components for Selected Public Transportation Modes in the San Francisco Bay Area. Institute of Urban and Regional Development, Univ. of California, Berkeley, Jan. 1974.
14. D. Lee. The Costs of Private Automobile Usage to the City of San Francisco. Institute of Urban and Regional Development, Univ. of California, Berkeley, Oct. 1971.
15. L. A. Merewitz. The Full Costs of Urban Transport, Part II: Marginal Costs of Fixed-Rail Rapid Transit Service in the San Francisco Bay Area. Institute of Urban and Regional Development, Univ. of California, Berkeley, Monograph 20, 1975.
16. L. A. Merewitz. Cost Overruns in Public Works.

In Benefit Cost and Policy Analysis (W. Niskannen, ed.), Aldine Publishing, Chicago, 1973, pp. 217-295.

17. J. Meyer, J. Kain, and M. Wohl. The Urban Transportation Problem. Harvard Univ. Press, Cambridge, Mass., 1965.
18. D. R. Miller, B. C. Goodwin, G. A. Hoffman, and W. H. T. Holden. Cost Comparison of Busway and Railway Rapid Transit. HRB, Highway Research Record 459, 1973.
19. J. Miller and J. Rea. Comparison of Cost Models for Urban Transit. HRB, Highway Research Record 435, 1973.
20. R. Pozdena. A Methodology for Selecting Urban Transportation Projects. Institute of Urban and Regional Development, Univ. of California, Berkeley, Monograph 22, July 1975.
21. M. Reed. The Economic Cost of Commuting. Highway Users Federation for Safety and Mobility, Washington, D.C., Technical Study Memorandum 13, July 1975.
22. M. Reed. Comparison of Urban Travel Economic Costs. Highway Users Federation for Safety and Mobility, Washington, D.C., Technical Study Memorandum 6, Feb. 1973.
23. Cost Estimating Relationships for High-Speed Ground Transportation Systems. Resource Management Corp., Bethesda, Md., March 1969.
24. R. Roess. Operating Cost Models for Urban Public Transportation Systems and Their Use in Analysis. TRB, Transportation Research Record 490, 1974.
25. D. B. Sanders and T. A. Reynen. Characteristics of Urban Transportation Systems: A Handbook for Transportation Planners. De Leuw, Cather and Co., May 1974.
26. Wilbur Smith and Associates. Bus Rapid Transit Options for Densely Developed Areas. U.S. Department of Transportation, Feb. 1975.
27. V. R. Vuchic and R. M. Stanger. Lindenwold Rail Line and Shirley Busway: A Comparison. HRB, Highway Research Record 459, 1973.
28. J. Wells et al. Economic Characteristics of the Urban Public Transportation Industry. Institute for Defense Analyses, Arlington, Va., Feb. 1972.
29. M. Wohl. An Analysis and Evaluation of the Rapid Transit Extension to Cleveland's Airport. HRB, Highway Research Record 417, 1972.

Current Status of State-Level Support for Transit

R. L. Carstens, C. R. Mercier, and E. J. Kannel, Engineering Research Institute, Iowa State University

Data were gathered by means of questionnaires received from 49 states and personal interviews with state transit officials in 22 states concerning state programs for assisting local transit operations. Twenty-four states provide financial assistance for transit from state funds. Such support may be used for capital improvements, operating assistance, technical planning, or special projects. The states vary widely in the extent to which they participate in such programs. Most state funds are derived from general revenue sources, although some states have established a state transportation fund to finance transit assistance as well as programs for other modes. A few states use special tax sources that are earmarked for their transit programs. Four general methods of allocating funds among transit operations are in use: purchase of service agreements, formula allocations, the revenue generating base of a transit jurisdiction, and allocation on a first-come, first-served basis. Several forms of indirect assistance to local transit operators were also identified in the course of this research.

Financial assistance to local public transit from state revenues is both significant and well-established in many states. State support has been provided through direct funding of capital expenditures, operations, and demonstration programs and indirect means such as tax relief and contributions for technical planning.

The roles of states in providing financial support for transit have been summarized (1). However, many state programs recently have undergone significant changes. A number of additional states have become heavily involved financially with local transit whereas others are now in the process of surveying local transit needs and considering assistance programs. Factors such as inflation, the deteriorating financial position of local operators, the pronounced limitations of local revenues to meet costs or match federal transit program funds, energy shortages, and an increased public awareness of the unmet transportation needs of significant portions of the population have all served to increase the likelihood of a state becoming involved in financing local transit services.

The experience developed by those states that have established funding programs includes consideration of funding levels, sources of funds, cost-sharing splits, and methods of allocation to local transit operators. The state of Iowa undertook a research project to summarize and evaluate the experience of other states to aid in the development of a transit planning and assistance program for Iowa (3).

The data discussed in this paper were compiled primarily through questionnaires completed and returned by all the other 49 states and by personal interviews with key personnel in 22 states.

DISTRIBUTION OF STATE TRANSIT FUNDS

States that provide financial assistance for local transit have generally tailored their programs to supplement federal funding. However, data were gathered for this research before Section 5 of the Urban Mass Transportation Act was implemented. Therefore, it would be reasonable to expect some adjustments to the distribution and allocation of state funds now that federal funds can be used for operating assistance. A few other exceptions to this pattern occur in the case of some research and demonstration programs, free or reduced fares to the elderly, and technical studies. Such projects, although generally eligible for federal funds, may not receive federal support but are deemed to meet significant state or local needs.

A total of 24 states indicated that they provided some form of financial assistance to local transportation organizations. Although the other states did not indicate that they provide financial support, they may provide technical assistance or otherwise aid local transit services. States that do not provide financial assistance to transit generally are rural and have few major population centers. Several of these states currently are debating the relative merits of forming departments of transportation as well as the issue of providing financial assistance to local transit.

Assignment of funds for specific needs varies widely. States may provide funds for capital improvements, operating assistance, planning, or any combination of these. In some instances, nondedicated funds may be provided, in which little guidance is given on the use of these funds.

Two states fit the latter category. California returns

Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

proceeds of a 0.25 percent sales tax, of a total of 4 percent, to local governmental jurisdictions according to the amount collected in that area. These funds are earmarked for transportation purposes, and priority is given to administration, planning, development of bicycle and pedestrian facilities, and support of public transit. After these needs are met, remaining funds may be used for streets and roads, Amtrak, and payments to common carriers for public transportation services under contract.

In the state of Washington, communities and other public authorities that operate public transportation systems can levy a 1 percent tax on the fair market value of vehicles registered within their jurisdictions. This levy becomes a credit on the state motor vehicle excise tax of 2 percent and is returned to the local jurisdiction. These funds may be used for planning, operations, or capital improvements but must be matched dollar for dollar from non-fare-box revenues.

Generally, funds are assigned according to legislative mandates. The current priorities for expenditures mandated by legislation are based on a variety of rationales, a topic that is beyond the scope of this study. The important issues discussed in this report include the tendency for states currently providing financial assistance to pay part or all of the nonfederal share of costs and how these funds are distributed among eligible transit agencies.

State Grants for Capital Improvements

Most of the financial support for capital improvements for local transit is in the form of federal aid. Up to now funds have come primarily through Section 3 of the Urban Mass Transportation Act of 1964, as amended. Currently, eligible recipients receive federal grants equal to 80 percent of the costs, and the remaining funds come from local or state sources.

A total of 18 states provide a portion of the local share (Table 1). In general, they have directed their resources toward supporting projects eligible for federal grants in an effort to generate federal funds with state funds.

Cost-sharing ratios vary widely among states, as given in Table 1. Four states provide all local matching funds, five provide more than half the local share, and four more provide half. Some states vary their contributions. Florida normally contributes 50 percent, but, if the project is statewide in scope and impact, it provides all the local share. In Maryland, the local share of the Baltimore system comes entirely from state funds, but the remainder of the state gets 75 percent of the local share. Massachusetts may pay up to one-half of the local share. However, in practice, the state contributes nothing for a good operation and 10 percent (half of local share) for a poor operation or one just beginning. Michigan pays 80 percent of the local share, except for small grant applications, which are fully funded. Ohio's contribution, which is not based on a strict formula, varies but averages about 20 to 25 percent. However, no single agency can receive more than 20 percent of the total state funds available in any year. The Virginia legislature distributes funds directly to the five major urbanized areas and pays 85 percent of the local share for the remaining urban areas. Even when a state has a formula, the state contribution may vary. Illinois has four provisions whereby the state can pay more than the usual two-fifteenths of the total cost.

The impact of federal grants for capital improvements is emphasized by the fact that only three states reported a program of grants from state funds for projects not eligible for federal funds. Florida grants up to one-half of the cost of projects with localized scope and impact, up to 100 percent of small local projects to install or upgrade safety equipment, and all of the cost when local or area sponsorships cannot be determined. Illinois can provide two-thirds of the cost if the project fulfills an extremely urgent need. The state can also make loans to local jurisdictions so that projects eligible for federal approvals are not delayed. Tennessee can pay one-half of the total cost of a project that cannot be federally funded.

Operating Assistance

Procedures for distributing operating assistance from the state to local transit agencies also vary. Much of the difference can be attributed to the desire of state legislatures to provide incentives for improved service and good management. In all, 14 states provide funds for operating assistance, including California and Washington. Table 1 gives a complete list.

Connecticut and Rhode Island pay all operating losses; however, Connecticut normally will not pay all if revenues do not equal or exceed 60 percent of the operating cost. The intent in New Jersey is to pay 75 percent of the operating losses of buses and all losses on commuter railroad services. Massachusetts grants one-half of the operating loss, providing the cost to the public does not exceed two-thirds of the cost of the operation (revenues should provide at least one-third). Maryland assumes all the operating losses of the Baltimore system but one-half of the losses of other systems.

Michigan uses an allocation formula that may provide up to 33 percent of operating costs. The legislature of New York allocated a fixed portion of its funds during fiscal year 1975 to the Metropolitan Transportation Authority and other regional authorities. The remaining funds were disbursed under an incentive program based on transit service and ridership. Pennsylvania pays up to two-thirds of operating losses, but the amount cannot exceed 50 percent of the operating revenues.

Technical Assistance

In the questionnaire used in this research, technical assistance referred to planning, design, or both. However, grants for technical assistance are used only for planning in most states.

Although additional states very likely include some level of transit planning as part of statewide planning efforts, only 18 specifically indicated direct financial support (Table 1). A few states provide this assistance from their staff, to the extent that this could be considered a line item in their budget. Some do as much as possible with their personnel and assist in the expense of hiring consultants for the remainder. Most of the states have specific formulas for allocating funds as a portion of the local share of federally financed studies. Where the state provides financial assistance, a minimum of 50 percent of the local share is provided from state funds.

The dollar value of grants for technical assistance is not great when compared to the amounts spent for capital improvements and operating subsidies. In some states, funds are appropriated to assist local jurisdictions in their quest for federal grant money for transit, particularly in speeding up the process. In others, these funds are used to pinpoint needs for either initial financial assistance or continuing aid.

Assistance for Special Projects

A few states have appropriated funds for special projects to solve specific needs. Most of these projects fit three categories: reduced fares for the elderly, demonstration projects, and transportation for the handicapped (Table 1).

Seven states, Illinois, Maryland, Nebraska, New Jersey, Ohio, Pennsylvania, and Wisconsin, indicated that funds are available to local jurisdictions for reduced or free fares for the elderly. For example, Nebraska has appropriated $1 million in part to reimburse metropolitan-operated bus lines for providing service to persons 60 or older during off-peak hours for 10 cents or less. Pennsylvania has appropriated 30 percent of gross revenues from the state lottery ($11 million) for free transit service for the elderly during nonpeak hours. Illinois provides operating assistance of a maximum of 25 cents per rider (up to one-half) for reduced fares for elderly persons and students. The New Jersey program helps provide off-peak transit rides at half fare to the elderly. Reduced fares for the elderly are subsidized by Maryland in Baltimore and by Wisconsin in Milwaukee. Ohio has appropriated $2 million to reimburse operators who reduced elderly fares by 10 cents for calendar year 1975.

Delaware has established the framework of a system of specialized transportation for the elderly and the handicapped. It is known as the Delaware Authority for Specialized Transportation and operates in one county. It will be expanded to cover the state and will receive financial assistance from the state.

Although a number of states are doing studies or reviewing proposals for demonstration projects, only seven indicated that funds are appropriated specifically for demonstration projects. In general, cash resources put into these projects are not large. Indeed, sometimes only one project is funded, but it is the one among several proposals that showed the greatest promise for statewide application.

Accordingly, the trend is to increase the level of state participation if the project may show broad statewide application. Florida, Michigan, Pennsylvania, and Wisconsin are the most extensively involved in demonstration projects.

The only remaining special projects were listed by Pennsylvania. In Pennsylvania, projects involving promotion or advertising are eligible for a 50 percent state match, and straight research is funded 100 percent by the state.

SOURCES OF FUNDS

State Revenue

The 24 states that provide some financial assistance to local transit are given in Table 2 together with the sources and the amount budgeted in fiscal year 1975. It is clear that state general funds are most often used as sources of revenue for public transit; state transportation funds run a distant second. (State transportation funds are either dedicated funds used by all modes of transportation or highway trust funds derived from road use taxes, a portion of which is appropriated for public transportation.) In a few cases, specific sources of revenue are collected and earmarked for use by public transit. These include sales tax (California and Illinois), motor vehicle registration fees (Illinois and Washington), cigarette tax (Massachusetts), and state lottery receipts (which are used to support reduced fares for elderly in Pennsylvania). All of these are revenues collected statewide and do not include any local-option taxes collected by the state and returned to the local jurisdiction.

The actual amount of state money spent for local transit varies widely, but urban states generally spend much more than rural states. In some states, although current spending levels are low, significantly higher levels are expected in the near future, depending on legislative mandates. For others, current expenditures will be adjusted mostly by economic factors including energy costs, federal cost-sharing, and inflation. A few states are spending small amounts to assist local operators in determining their needs and in seeking federal assistance or to determine the extent of statewide needs. This could be translated into more substantial funding in the future.

Local Revenue

Information on local sources of revenue (other than state funds) was obtained mostly from the states visited for personal interviews. Enough information was gathered from these states to show definite trends.

The primary revenue sources of funds for local jurisdictions were general funds and federal revenue sharing. Although there are a number of ways used to replenish general funds, the most important one is the property tax. Some states have a local option, providing for a millage rate dedicated for public transit. Although this is not from general funds, the source is the same: local property tax.

Several states use local income tax or local sales tax revenues. Atlanta, Georgia, uses a $0.01 sales tax, while the rest of the state uses general funds. There are a few other sources of income, generally limited to one state. Some of these are

1. Revenue from liquor sales,
2. Household tax,
3. Business and occupation tax (flat rate on gross receipts),
4. Toll revenues, and
5. Motor vehicle taxes.

In several states, sources of revenue other than general funds can be used, but generally such use must be approved by a referendum. Some of these are used by local jurisdictions in California, Florida, Illinois, Kentucky, Michigan, Nebraska, New York, Ohio, Oregon, Utah, Virginia, Washington, and Wisconsin.

ALLOCATION OF TRANSIT ASSISTANCE FUNDS

A critical issue in the implementation of state transit assistance programs is the question of allocating limited resources among eligible transit operations. In general, an allocation procedure should be judged by its ability to distribute funds to agencies in proportion to need, to enable the state to maximize the effectiveness of funds expended by establishing service quality guidelines, and to provide the receiving and disbursing agencies sufficient information about the amounts and the temporal flow of money so that they may develop effective, workable operating plans.

Approaches used to distribute state funds to local agencies have varied widely depending on the type of program and the state. Disbursement of demonstration program grants potentially imposes the least difficulty because the amounts involved usually are small and there generally is no commitment to provide each agency with a fair share of available funds. Instead, funds frequently can be distributed on a first-come, first-served basis to those applicants with proposals most responsive to program objectives.

Capital assistance programs potentially are more difficult to administer. However, persons interviewed as part of this research did not appear to have encountered any particular problems in administering their state programs. State-level evaluation of individual grant requests ranges from the extremely superficial to the very comprehensive. As an example of the latter, the New York State DOT evaluates all assistance requests for compliance with the State Master Plan. For the most part, however, state assistance for capital improvements is contingent on approval by the federal agency (generally UMTA) that provides funding.

Although actual levels of state assistance vary, most states provide a fixed percentage of the capital costs (Table 1). Of the 18 states providing assistance for capital improvements, 10 pay a fixed percentage, two (California and Washington) provide nondedicated funds with little guidance, and four use a fixed percentage but will pay all the local share under certain conditions (two for metropolitan areas, one for projects of statewide significance, and one for small requests).

Because of the limited experience with operating subsidies at both the federal and state levels, this form of assistance has generated the most concern by funding agencies. Distribution procedures currently in use have been classified into four categories, which are discussed and evaluated here. Details of operating assistance programs of specific states were discussed previously.

Purchase of Service Agreements

In the purchase of service agreements, the state contracts with the local agency to furnish transit services in a given service area. In return for state funding, the operator agrees to meet certain performance criteria. The state may reserve the right to approve routes and headways as a measure of level of service and may exert control in the form of setting standards for schedule reliability, fares, and marketing programs. Penalties may be involved in the form of reduced state aid if the operator fails to meet the performance standards agreed to in the contract.

Contracts may provide up to 100 percent funding of the operating deficit. Funds are appropriated based on the deficits of individual operations during the previous year. States using purchase of service agreements include New Jersey, Connecticut, and Pennsylvania.

The use of purchase of service agreements is beneficial to the state in that it allows for control of the quality of service. It is also desirable to the operator because he can provide quality service in the face of increased costs without increasing fares, decreasing service, or depleting cash or capital reserves. Passengers benefit because of operator incentives to provide quality service inasmuch as the contract may limit or withold payments to operators if service falls below established performance standards.

The program is not without problems, however, because escalating costs may outstrip the fixed amounts made available by a legislature. In at least one case, the costs contracted for by a state exceeded the amount of funds available.

Formula Allocations

Another common procedure for distributing a fixed appropriation to eligible transit systems is by formulas based on population, service characteristics, or both. Two states, Michigan and New York, use this approach.

The Michigan formula considers two parameters, urban population as a proportion of statewide urban population and revenue-kilometers of service, also as a proportion of the statewide total. Each factor is weighted equally in the determination of the portion of total available funds for which a community is eligible. An additional constraint, however, which may limit the actual state funds received, is that operating subsidies may not exceed 33 percent of operating costs.

New York uses two forms of allocation, a legislative appropriation for a fixed amount to each of five regional authorities and a formula allocation to other agencies. The allocation formula is currently based on the number of passengers and vehicle-kilometers of service; the reimbursement rate differs for buses, light rail vehicles, and commuter rail.

Formula allocations can be adapted to provide an effective distribution procedure and incentives for service improvements and operational efficiencies. They permit transit operators to estimate with reasonable accuracy the amount of support that will be forthcoming, providing that the amount of appropriate funds is stable and the state has a mechanism whereby all operations can receive a share of available funds.

However, formula allocation also has potential problem areas. Just as it was recognized by New York that different forms of public transit have different operating costs and potentials for generating revenue, it must also be recognized that costs and revenue potential vary with the size of urban areas. Furthermore, a transit operation may be highly desirable from the standpoint of providing an essential social service but have particularly low potential for generating ridership and revenues. Careful evaluation is required in such cases to help ensure that the formula used gives adequate attention to the special needs of operators.

A second major concern is that the parameters used should appropriately reflect the needs of transit agencies. For example, whereas revenue-kilometers of service may uniformly reflect operating costs in cities of similar size, route-kilometers may not be a uniform indicator. In one city, for example, service may be provided on 30-min headways, and in another city service might be provided only twice daily, although the number of route-kilometers might be the same for both.

In this connection, it should be pointed out that the ability to develop viable transit programs is based on a reasonable consistency in annual funding levels. Extreme fluctuations in legislative appropriations will require annual adjustments in the weights given to formula parameters. Some annual variation is anticipated, but large changes in funding levels will hinder program development.

Revenue Generating Base of Transit Jurisdiction

Three states, California, Illinois, and Washington, reported that transit funds were apportioned on the basis of taxing levels in the transit district. Summaries of the operation of these programs follow.

1. California returns a portion of sales tax proceeds to counties to be used according to a priority schedule for (a) administration, (b) planning, (c) facilities for exclusive use of bicycles and pedestrians, (d) public transportation, and (e) other transportation needs. Transit agencies are required to report basic operating data to the state DOT. Within counties, allocations are based on population. In 1974, 61 percent of these funds were used for transit.
2. Illinois returns a portion of sales tax collected in a given district upon receipt of an appropriate operating plan consistent with local needs and the generation of local matching funds.
3. Communities and other public transit authorities in Washington may levy an excise tax on vehicles registered in their jurisdiction, but they must produce local matching funds.

Table 1. Proportion of state funds allocated to local transit.

State	Capital Improvements	Operating Assistance	Technical Assistance[a]	Special Projects Funded
Alaska	Not known	None	Yes	
California	Varies	Varies	Yes	
Connecticut	All	All	Yes	
Delaware	All	More than half	Yes	
Florida	Half, varies	None	Yes	Demonstration grants
Georgia	Half	None	Yes	Demonstration grants
Hawaii	None	None	Yes	
Illinois	More than half	More than half	Yes	Reduced fares for the elderly
Kentucky	None	None	Yes	
Maryland	More than half, varies	Half, varies	Yes	Reduced fares for the elderly, demonstration grants
Massachusetts	Half, varies	Half	No	
Michigan	More than half, varies	Varies	Yes	Demonstration grants
Minnesota	None	More than half	No	Demonstration grants
Nebraska	None	None	Yes	Reduced fares for the elderly
Nevada	None	None	Yes	
New Jersey	All	More than half, varies	No	Reduced fares for the elderly
New York	More than half	Varies	No	
Ohio	Varies	None	No	Reduced fares for the elderly
Pennsylvania	More than half	More than half, varies	Yes	Reduced fares for the elderly, demonstration grants, other
Rhode Island	All	All	Yes	
Tennessee	Half	None	Yes	
Virginia	More than half, varies	None	Yes	
Washington	Varies	Varies	Yes	
Wisconsin	None	More than half	Yes	Reduced fares for the elderly, demonstration grants

[a]Specifically allocated funds (not including statewide planning).

Table 2. Sources of revenue for state financial assistance to transit.

State	Source	Total Dollars for Fiscal Year 1975
Alaska	Appropriations from general revenues	10 000 000
California	State sales tax	103 000 000
Connecticut	State transportation fund	32 000 000
Delaware	Appropriations from general revenues	4 200 000
Florida	State transportation fund	7 600 000
Georgia	Appropriations from general revenues	428 000[a]
Hawaii	Appropriations from general revenues	303 000[a]
Illinois	Appropriations from general revenues,[b] state sales tax,[c] registration fees[d]	92 250 000
Kentucky	Appropriations from general revenues	200 000
Maryland	State transportation fund	77 800 000
Massachusetts	Appropriations from general revenues, cigarette tax	57 000 000
Michigan	Appropriations from general revenues,[e] state transportation fund	26 000 000
Minnesota	Appropriations from general revenues	6 000 000
Nebraska	Appropriations from general revenues	1 000 000
Nevada	State transportation fund	75 000
New Jersey	Appropriations from general revenues	97 500 000
New York	Appropriations from general revenues	100 000 000[f]
Ohio	Appropriations from general revenues	3 400 000
Pennsylvania	Appropriations from general revenues, state lottery	118 600 000
Rhode Island	Appropriations from general revenues	2 000 000
Tennessee	Appropriations from general revenues	1 600 000
Virginia	Appropriations from general revenues,[e] state transportation fund	21 900 000
Washington	Registration fees	10 000 000
Wisconsin	Appropriations from general revenues	7 000 000

[a]Fiscal year 1974 data.
[b]For capital improvements.
[c]For operating expenses.
[d]Only portion of fees collected in RTA area.
[e]Dedicated funds are the primary source of revenue; appropriations from general fund are small in comparison.
[f]Plus a variable portion of bonds used for capital improvements.

The return of funds collected by a state to the local communities does not necessarily imply that local agencies can use such money indiscriminantly. As indicated above, states using this procedure may require extensive local reporting, development of an operating plan, and use of local matching funds. The distribution procedure could establish fundamental performance standards as a basis for receiving an allotment for which a local agency is eligible.

The primary advantage of this allocation methodology over the other concepts is that both the state and the operating agency can better estimate the annual funds that will be involved because the base for prediction (sales tax or motor vehicle assessed valuation) may be more predictable than are annual legislative appropriations. Further, an individual agency is not competing against every other operation for a piece of a fixed apportionment but can instead plan on having available revenues based on the economic growth of the area. In this program the state can still establish level-of-service guidelines, performance standards, and the operational reports necessary to evaluate service quality.

Table 3. Indirect assistance to local transit operators.

Type of Assistance	Participating States
Exempt from local property taxes	Nearly all
Exempt from motor fuel taxes	Nearly all
Authority to sell tax exempt bonds	About half
Exempt from state income taxes	About half
Exempt from local income taxes	Less than half[a]
Exempt from motor vehicle registration fees	Most
Fares exempt from sales and use tax	Most
Exempt from special assessments	About half
Exempt from excise taxes	About half
Lease of operating equipment at less than cost	Five[b]
Exemption from franchise-license fee	About half

[a]Use of local income taxes for revenues is common but not widespread.
[b]Personal interviews indicated a lack of enthusiasm for state involvement in direct purchase of equipment.

This allocation procedure does not, of course, guarantee satisfaction of every community's needs even though there is no direct competition for a fixed fund. The legislation establishing such a program will likely be set up to provide sufficient assistance, on the average. If an area is economically depressed relative to other areas or has higher transit needs relative to its revenue generating potential, the transit operator may find that both assignable state funds and local matching funds are inadequate to meet transit needs. Thus, special consideration of individual needs may still be necessary.

First-Come, First-Served Allocation

In a first-come, first-served allocation, the first agencies to submit requests for assistance are given funds according to their established needs. Generally, service incentives are lacking, although the state may require collection of certain data, submission of a management plan, or audits of the operations. State contributions are set at a given proportion of operating losses. Sometimes, a maximum public share of operating costs is set or a maximum percentage of operating costs to be paid with state funds is established.

Allocation of funds on a first-come, first-served basis is likely to be inadequate overall because of the possible inequality in distribution and the inability to base planning on a specific funding level. Although management of this distribution procedure may be satisfactory during the developmental stage of a state subsidy program, the potential for pressures from new operating systems suggests that more definitive and equitable procedures are desirable.

INDIRECT ASSISTANCE

There are a number of nonmonetary forms of assistance that can be provided to local transit operators that collectively could be of significant benefit to them. This is often referred to as indirect assistance and generally is given in the form of exemption from payment of certain taxes or fees. To a tax collecting body, this represents income forgone. To a local transit operator, it means a reduction in operating expenses. For the most part, exemptions seem to be limited to public operators, in part because of the ever-decreasing number of private operators. Some of the more common forms of direct assistance are given in Table 3. (Only 70 percent of the states completed this part of the questionnaire.)

CONCLUSION

The information contained in this report shows that more states are providing more of the local share of the capital and operating costs of local transit systems. There is also a tendency to subsidize operating costs by using allocation procedures that give the local operator incentives to provide a good level of service for transit users. On the other hand, several states have not yet made funds available for local transit. Their future efforts can benefit from the experience of their colleagues in other states, to suggest transit policies and programs that can afford an incentive for local transit management to develop cost-effective solutions that provide better service.

ACKNOWLEDGMENT

The study reported here was conducted by the Engineering Research Institute, Iowa State University. Financial support for the study was provided by the Urban Mass Transportation Administration, the Iowa Department of Transportation, and the Engineering Research Institute. Research interpretations are those of the authors, however, and do not necessarily reflect the views of the sponsors.

REFERENCES

1. W. D. Hart. Public Financial Support for Transit. Highway Users Federation for Safety and Mobility, Washington, D.C., Technical Study Memorandum 7, 1973.
2. Transit Assistance Program for Iowa. Engineering Research Institute, Iowa State Univ., Final Rept., 1975.

Transit Deficits: A Projection for New York State

David T. Hartgen and Stephen M. Howe, Planning and Research Bureau, New York State Department of Transportation

This paper summarizes recent work at the New York State Department of Transportation on the future of transit operating deficits in the state. Transit cost projections are made for three inflation levels for each of 13 transit properties, which serve 95 percent of New York State riders. Based on 1964-1973 data, aggregate demand models relating ridership to fare and service levels are calibrated for each operation and are used to forecast ridership and revenues to 1980 under a series of fare and service assumptions. The analysis shows that (a) transit costs will about double during the 1974-1980 period, (b) fare elasticities for transit ridership are about -0.25 for large operations and -0.55 for smaller operations, (c) ridership will stabilize at about 2.0 billion riders annually if current fares and services are maintained, and (d) transit deficits (operating costs minus revenues) will rise from $248 million in 1973 to $1324 million by 1980.

In 1974 New York State established a $200 million transit operating assistance (TOA) program for state communities. Under this program five large metropolitan areas (Figure 1) receive direct grants, and other transit operators are allocated funds by a formula based on passengers, vehicle-kilometers, and residents served. The state and communities share equally in the program (in the large metropolitan areas participation is mandated). In 1975, the program was continued at a slightly higher ($206 million) funding level. This operating assistance, combined with federal and other state and local funds, enabled transit operations in New York to hold fares and service at their January 1974 levels, except for recent (September 1975) increases in the New York City area.

The New York State Department of Transportation is responsible for undertaking an annual study of this TOA program to review program effectiveness, fairness of funds distribution, transit productivity, and prospects for the future. The results of these analyses (_1_, _2_) have been submitted to the governor and the legislature to aid in developing an effective long-range approach to financing transit systems and evaluating the services provided by each system. As part of its study, the New York State DOT has developed and evaluated several options for operating assistance by using available statistics on transit companies and forecasts of ridership, revenues, operating costs, and deficits for various fare and service assumptions. This paper describes the state DOT's modeling and forecasting efforts in regard to (a) transit cost models; (b) ridership and revenue models for each operation in the state; and (c) projections of transit ridership, revenue, costs, and deficits under various fare and service assumptions.

DATA SOURCES

Data compilation and modeling covered more than 95 percent of the bus, subway, and commuter rail transit ridership in the state. Basic information was compiled for each of 13 major transit operations in New York State. In the New York City area, the transit operations included

1. Private bus companies,
2. Manhattan and Bronx Surface Transit Operating Authority (MABSTOA),
3. Other public bus systems,
4. Subway system, and
5. Commuter rail operations.

Other operations in the state included those in

6. Westchester County,
7. Nassau County,
8. Buffalo,
9. Rochester,
10. Syracuse,
11. Albany-Schenectady-Troy,
12. Binghamton, and
13. Utica-Rome.

Information was obtained from company records and other sources on the number of annual riders, annual bus-kilometers, fare, area employment, population, and other statistics (such as the consumer price index) for the period 1964-1973.

Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

COSTS OF PUBLIC TRANSPORTATION

In this analysis transit deficits are computed as the difference between the costs of transit operations (excluding capital investments) and revenues obtained from transit riders, plus revenues from other sources such as advertising. The costs of bus and subway transit operations in New York State have risen from $436 million in 1964 to $922 million in 1973, paralleling national trends. Commuter rail operating costs in 1973 were $250 million (Figure 2). Of particular importance in these trends are rapidly rising costs in fuel and power, wages, and retirement benefits.

The cumulative effect of these trends has resulted in a rapidly rising index of transit costs during the 1964-1973 period (Figure 3). The rate of rise is faster than that of the economy in general, because (a) wages, retirement, and other fringe benefits were generally low in the transit industry before the public takeovers, which occurred in this period, and (b) fuel and power costs have increased rapidly in recent years.

Transit costs were modeled in a straightforward manner. First, the transit cost index based on three inflationary trends was projected into the future (Figure 3). For a given transit system, then, the 1973 average cost per vehicle-kilometer was multiplied by the transit cost index to obtain estimates of costs per vehicle-kilometer for future years. Finally, for a given future year the number of vehicle-kilometers planned under a particular service policy was multiplied by estimated cost per vehicle-kilometer for that year to obtain total operating cost. The simple formulation

$$\text{Future cost}_t = (\text{1973 cost per vehicle-kilometer}) \times (\text{inflation factor}_t) \times (\text{vehicle-kilometers planned}_t)$$

is well-suited for forecasting costs under an array of service policy options.

RIDERSHIP AND REVENUES

While costs rose, New York State transit ridership (bus, subway, and commuter rail) fell during the 1964-1973 period (Figure 2) to about 2.09 billion annual riders. As ridership declined, fares were raised to increase revenues, an action which further encouraged ridership reduction. Through successive fare increases, revenues have kept up with costs (Figure 2) but only at the expense of declining ridership. Generally, fares have increased faster than the cost of living.

Forecasts of the revenue side of transit operations were based on investigation of different aggregate models relating ridership per resident to urban area and transit system characteristics. Results indicated that fare and service-level variables were the best estimators of transit ridership, for most cities. Linear models generally worked better than product forms. The following simple two-variable model was found to adequately describe ridership declines over a 10-year period.

$$\frac{\text{Annual ridership}}{\text{Population}} = a + b\,(\text{base fare}) + c\left(\frac{\text{annual vehicle-kilometers}}{\text{population}}\right)$$

Base or nominal fare was found to be a much better predictor than deflated fare, which also was observed to be unreasonable in forecasting. These models were calibrated by least squares regression (3).

Table 1 gives the ridership models. Of particular interest is the finding that fare-increase elasticities for large operations (New York City and Buffalo) are all about -0.25 and for smaller metropolitan areas (except for Binghamton) are about -0.55. These findings generally parallel those of other researchers (4) and indicate that transit ridership in large cities is not so sensitive to fare increases as is the ridership in smaller cities. No such patterns appear in the service elasticities, however.

For each system, for each forecast year (1974-1980) total ridership and revenue were estimated for each of 12 fare-service policies (50 percent less, current, and 50 percent more service versus 0, 15-cent, current, and 60-cent fare). These relationships are given in Table 2 for revenue passengers. If the 1973 fares and service (current) levels are maintained through 1980, transit ridership is expected to rise only slightly (to 2.12 billion annual riders) during the period. If bus and subway fares on the average were raised to 60 cents for bus and subway and $2.10 for commuter rail (from $1.41 in 1973), transit usage statewide would fall about 28 percent to 1.513 billion riders by 1980. However, as discussed below, the resulting transit deficits at that time would not be much less than those projected with the current fare because potential revenue increases would be reduced by lost ridership and costs would continue to rise.

On the other hand, a substantial fare decrease (to 15 cents for bus and subway and 70 cents for commuter rail) would increase ridership by about 25 percent during the same period based on the assumption that the riders lost by fare increases would return as a result of similar fare decreases. This is a tenuous assumption according to Donnelly in a paper in this Record. If such reverse diversion is not so sensitive to fare decreases, ridership projections for reduced fares will be high and deficit projections low.

Similarly, if levels of transit service (defined as vehicle-kilometers) were cut 50 percent during the next 5 years, ridership would fall 37 percent to 1.334 billion annually by 1980. If service levels were increased 50 percent, about a 37 percent increase in ridership would occur in the same period.

In summary, the ridership has been declining but is expected to stabilize at about 2.12 billion annual riders if 1973 fares and service levels are maintained. Hence, without fare increases or service cutbacks, revenues are likely to remain relatively constant during the 1975-1980 period.

TRANSIT OPERATING DEFICITS

Because of increasing costs and declining revenues, transit operating deficits (costs minus revenues) have increased greatly since 1970. In 1973, total state deficits for transit were about $263 million; they rose to about $398 million in 1974. Data given in Table 3 show that, if 1973 fares and service are maintained, the gross operating deficit of all New York State transit operations is projected at $642 million for 1975 and $1324 million by 1980. Given 1974 as a base, 1975 deficits will be 61 percent higher and 1980 deficits 233 percent higher.

Increases in fare apparently do not materially affect the long-term financial status of transit operations. An average fare of 60 cents for bus and subway and $2.10 for commuter rail would result in a total state 1980 deficit of $1214 million, about $110 million less than projected with the current fare, but ridership would fall 28 percent. On the other hand, a significant fare decrease (to 15 cents) would generate 538 million more riders, but at a deficit $387 million greater than with the current fare. (Increases in operating cost to handle increased ridership are not included.)

The conclusion is that significantly lower fares would increase ridership on the order of 25 percent, but this would only decrease net revenue and increase deficits. On the other hand, increases in fare would further reduce

Figure 1. New York State regional transportation authorities.

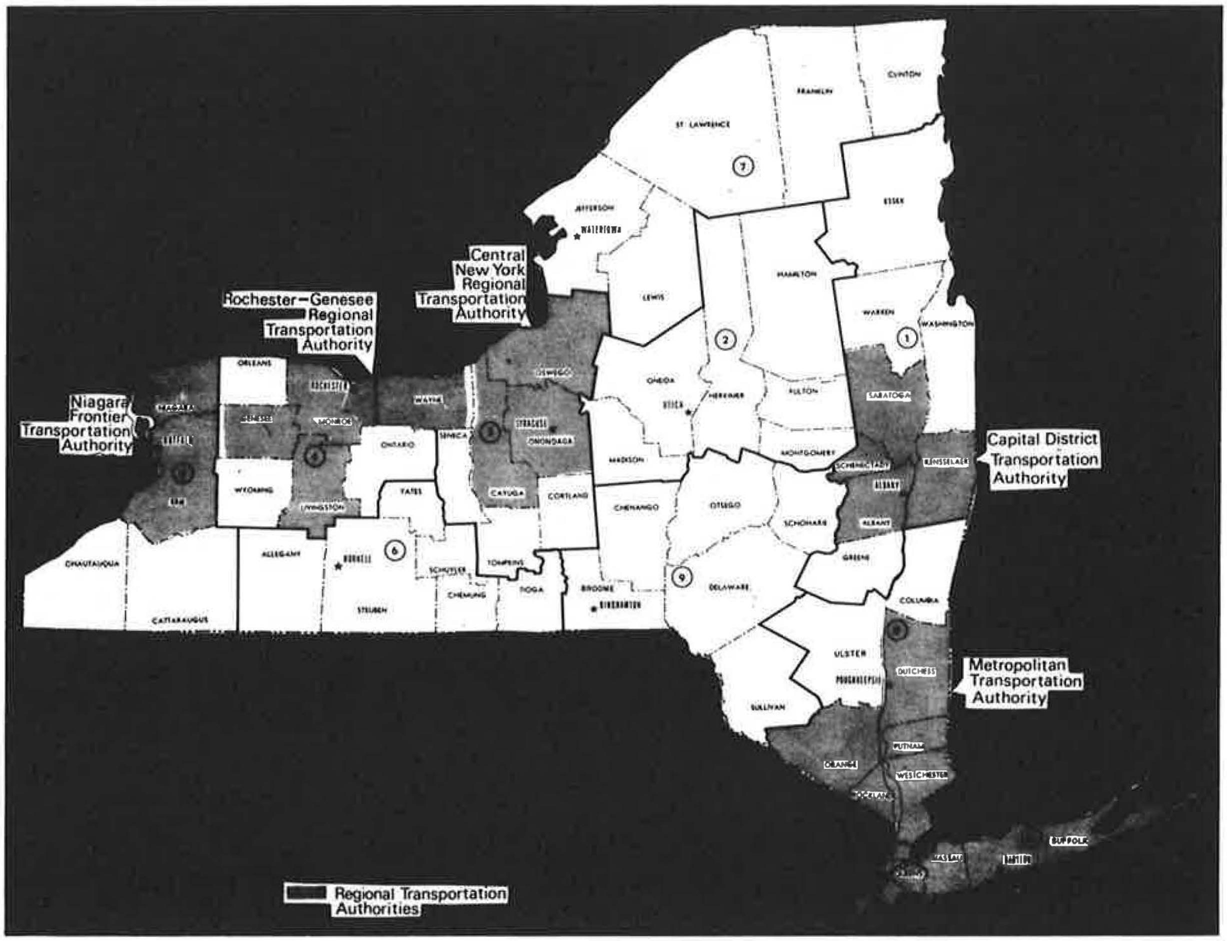


Figure 2. Ridership, revenue, and expenditures for New York State.

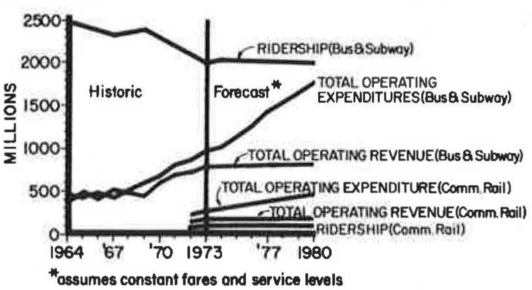


Figure 3. New York State transit cost index.

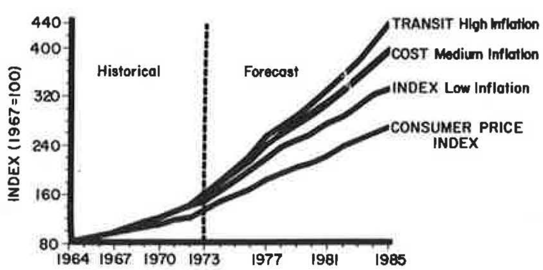


Table 1. Transit travel demand models for New York State areas.

	Coefficients			Demand Elasticities			
Transit System	Constant	Fare	Vehicle-Kilometer/ Population	Fare	BM/Population	R^2	F Overall
New York City							
Private bus	8.57	-0.10	4.88	-0.25	0.52	0.76	9.7
MABSTOA	30.15	-0.46	7.69[a]	-0.24	0.57	0.93	37.1
Other public buses	-0.04[a]	-0.59	13.50	-0.26	1.26	0.96	80.1
Subway	109.12	-1.52	3.45	-0.23	0.55	0.95	57.7
Commuter rail	25.82	-0.10	0.10[a]	-0.70	0.04	0.98	137.9
Westchester County	31.08	-0.27		-0.57		0.92	79.5
Nassau County	10.46	-0.23	4.01	-0.56	0.87	0.99	423.0
Buffalo	20.61	-0.22[a]	2.30[a]	-0.25	0.50	0.93	38.1
Rochester	18.78	-0.52	4.80	-0.54	0.86	0.88	21.7
Syracuse	20.46	-0.47	2.87	-0.56	0.61	0.96	72.8
Albany-Schenectady-Troy	14.74	-0.31	7.55	-0.52	0.70	0.91	30.9
Binghamton	16.65	-0.33	0.95[a]	-1.15	0.24	0.90	26.6
Utica-Rome	-1.26		4.53		1.14	0.85	40.2

Note: 1 vehicle-km = 0.6 vehicle-mile.

[a]Not significant.

ridership below the current levels (by about 28 percent for a 60-cent fare), and resulting deficits would continue to increase because the revenue gained would not offset increases in the cost of transit operations.

However, decreases in service would significantly reduce the deficits. With 50 percent less service, the 1980 projected deficit would be about $467 million, but ridership would fall 37 percent. A 50 percent increase in service would increase the deficit to $2182 million but generate 37 percent more ridership. Thus, decreases in service level would reduce deficits, but the impact on New York residents would be great.

CONCLUSIONS

The analysis suggests that there is no simple solution to the problem of rapidly rising transit operating deficits in New York State.

1. Transit operating costs are rising faster than the general cost of living; they are projected to double during the next 5 years.
2. Although most costs are wage related, no single cost item accounts for these increases. Large transit systems appear to be more expensive to operate on a kilometer basis primarily because of slower operating speeds caused by big city traffic congestion

Table 2. New York State transit ridership in thousands.

					1980 Ridership Projections[a]			
	Current Fare and Service				Current Service		Current Fare	
Operation	1973[b]	1974[a]	1975[a]	1980[a]	60-Cent Fare	15-Cent Fare	50% Less Service	50% More Service
New York City								
Private bus	90 996	92 432	92 400	92 245	83 439	119 462	59 859	124 630
MABSTOA	292 851	307 361	307 235	306 618	216 956	378 348	207 827	405 410
Other public bus	384 804	383 260	383 448	384 363	268 951	476 692	111 252	657 474
Subway	1 122 456	1 122 886	1 122 383	1 119 920	824 437	1 356 307	777 654	1 462 187
Commuter rail	93 897	98 538	99 770	103 998	46 823[c]	161 172[d]	101 580	106 417
Subtotal	1 985 004	2 004 477	2 005 236	2 007 144	1 440 606	2 491 981	1 258 172	2 756 118
Westchester County	18 111	17 866	17 982	18 638	14 137	26 051	18 638	18 638
Nassau County	19 066	18 963	18 963	18 959	14 176	29 548	9 389	28 528
Buffalo[e]	27 576	30 188	30 246	30 546	24 451	38 162	23 648	37 441
Rochester	17 656	17 597	17 579	17 493	9 012	28 095	7 929	27 058
Syracuse	10 599	10 146	10 166	10 266	2 844	16 204	6 342	14 190
Albany-Schenectady-Troy	11 025	11 323	11 342	11 458	5 347	16 346	7 250	15 666
Binghamton	1 671	1 592	1 597	1 621	295[f]	3 154	1 367	1 876
Utica-Rome	2 032	2 018	2 016	2 007	2 007	2 007	783	3 231
Subtotal	107 736	109 693	127 057	110 988	72 269	159 567	75 346	146 628
Total	2 092 740	2 114 170	2 132 293	2 118 132	1 512 875	2 651 548	1 333 518	2 902 746
Percentage change over 1974				+0.2	-28.4	25.4	-36.9	+37.3

[a]New York State DOT projections.
[b]Reported by operators.
[c]$2.10 fare assumed.
[d]70-cent fare assumed.
[e]Fare changed from 45 cents in 1973 to 40 cents in 1974.
[f]Unreliable forecast.

Table 3. New York State transit deficits (profits) in thousands.

					1980 Deficit Projections[a]			
	Current Fare and Service				Current Service		Current Fare	
Operation	1973[b]	1974[a]	1975	1980[a]	60-Cent Fare	15-Cent Fare	50% Less Service	50% More Service
New York City								
Private bus	(9 837)	(4 975)	1 771[a]	28 686	23 823	55 967	3 708	53 664
MABSTOA	4 139	13 458		112 098	89 241	162 662	26 968	197 228
Other public bus	25 876	43 038	470 000[c]	171 857	143 671	238 031	114 987	228 727
Subway	147 169	224 106		661 214	558 524	849 740	250 402	1 072 026
Commuter rail	84 127	112 742	157 706[c]	306 400	353 762[d]	339 240[e]	59 362	553 426
Subtotal deficit only	261 311	393 344	629 477	1 280 255	1 169 021	1 645 640	455 427	2 105 071
Westchester County	(1 728)	(578)	558[a]	5 005	4 537	9 111	(2 192)	12 202
Nassau County	(1 327)	32	1 640[a]	8 052	8 267	12 340	2 698	13 405
Buffalo[f]	(1 544)	421	3 345[c]	10 527	7 830	17 671	1 073	19 983
Rochester	101	1 359	2 704[c]	7 265	8 775	9 908	3 761	10 768
Syracuse	342	866	1 549[c]	4 612	6 688	5 891	1 509	7 716
Albany-Schenectady-Troy	585	1 060	1 995[c]	5 595	6 477	7 309	1 634	9 556
Binghamton	197	340	243[c]	975	1 569[g]	1 064	274	1 675
Utica-Rome	200	462	490[c]	1 420	577	1 661	626	2 214
Subtotal deficit only	1 425	4 540	12 524	43 451	44 720	64 955	11 575	77 519
Total deficit only	262 736	297 884	642 001	1 323 700	1 213 741	1 710 595	467 002	2 182 590
Percentage change over 1974			61.35	232.68	205.05	392.92	17.37	448.55
Net Total	248 300	392 331	642 001	1 323 700	1 213 741	1 710 595	464 810	2 182 590

[a]New York State DOT projections.
[b]Reported operating costs minus operating revenues.
[c]Estimated by operators.
[d]$2.10 fare was assumed.
[e]70-cent fare was assumed.
[f]Fare changed from 45 cents in 1973 to 40 cents in 1974.
[g]Unreliable forecast.

and somewhat higher labor costs.

3. On the revenue side, ridership has been declining and is projected to stabilize, under the assumption that no additional fare increases or service cutbacks will be implemented. Hence, revenues will be relatively constant over the foreseeable future.

4. Increases in fares appear to be generally counterproductive in that they simply drive away more riders and necessitate further service cutbacks to make up for lost revenues.

5. Thus, transit deficits are likely to continue rising if present trends continue. The gap between costs and revenues for commuter rail, bus, and subway operations is forecast at about $1324 million by 1980, based on 1973 fares and service and declining inflation rates.

REFERENCES

1. Public Transportation Operating Assistance: Evaluation and Options. Planning Division, New York State Department of Transportation, Feb. 1975.
2. Public Transportation Operating Assistance: Annual Report. Planning Division, New York State Department of Transportation, Oct. 1975.
3. Biomedical Computer Programs. Univ. of California, Los Angeles, 1968.
4. M. A. Kemp. Some Evidence of Transit Demand Elasticities. Transportation, Vol. 2, 1973, pp. 25-52.

Alternative Subsidy Techniques for Urban Public Transportation

Ronald F. Kirby and Robert G. McGillivray, Urban Institute

Subsidies for urban public transportation can be paid directly to transportation providers for supplying certain specified services or directly to transportation users in the form of discount transportation vouchers. These two subsidy mechanisms can be referred to as provider-side subsidies and user-side subsidies respectively. This paper discusses the likely advantages and disadvantages of three approaches urban communities can take to subsidizing public transportation: provider-side subsidies alone; user-side subsidies alone; and combined provider-side and user-side subsidies. Provider-side subsidies may be easier to administer than user-side subsidies, but they have often resulted in increased costs and in public dependence on a relatively small number of providers and services. User-side subsidies appear to offer more flexibility and efficiency; subsidized users can choose those providers and services that best meet their needs. The paper outlines a program of case studies and experiments designed to test hypotheses and fill major information gaps associated with these alternative subsidy approaches.

Subsidies for urban public transportation services have been advocated and in many circumstances provided on the basis of two social objectives:

1. Shifting some private automobile travel to high-capacity transit modes to reduce congestion, pollution, and fuel consumption and
2. Ensuring an acceptable level of mobility for those who are unable to use private automobiles, particularly the young, the elderly, the poor, and the handicapped.

But, although both of these objectives have gained wide acceptance within the United States, a great deal of debate exists over the way in which they can best be achieved. Of the approaches that have been suggested, a few have been implemented, a few others are on the verge of large-scale introduction, and still others have yet to be tried on a significant scale.

This paper is concerned primarily with the use of subsidies to achieve the second objective: ensuring adequate mobility for certain target groups. The various subsidy mechanisms that have been proposed are discussed under two general categories:

1. Provider-side subsidies, in which the subsidy is paid directly to the transportation provider (such as a transit authority or a taxicab operator) for offering certain specified services at fares that produce insufficient total revenues to cover the provider's costs; and
2. User-side subsidies, in which certain target group users are permitted to purchase transportation vouchers at a price substantially below the value of the vouchers to the transportation providers (users exchange these vouchers for transportation services, and the transportation providers then redeem the vouchers from the public agency at values agreed on in advance).

In the discussion that follows, the term user payment means the amount paid by the user for a trip, the term fare means the advertised price of the trip to a member of the general public, and the term cost means the cost of the trip to the provider. Under most provider-side subsidy schemes, the user payment is equal to the fare, and the average fare is well below the average cost. For most user-side schemes, however, the target group's user payment, in the form of discount vouchers, is less than the standard fare. In these cases, the average fare equals the average cost, including normal profit. Myers (6) suggests a user-side subsidy scheme in which the provider redeems the vouchers at a premium value well in excess of the cost of providing trips for the target group. The difference between the premium and the cost, the provider bonus, is used by the provider to cover other unprofitable services. Finally, where provider-side and user-side subsidy mechanisms are used in combination, there are both a target group user payment that is less than the standard fare and an average fare that is below the average cost.

Most subsidy mechanisms in widespread use at present are provider-side subsidies. Examples are direct capital and operating assistance provided under the Urban Mass Transportation Act of 1964 (as amended), direct operating subsidies provided by state and local governments, and contract arrangements between public agencies and transportation providers under which specified low-fare services are provided at a contract rate

Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

per vehicle-kilometer or per vehicle-hour. Examples of user-side subsidies are the sale of taxicab tickets or tokens to the elderly and the sale of transportation ticket books to certain handicapped and elderly residents; the Transportation Remuneration Incentive Program (TRIP) in West Virginia is an example.

This paper discusses the kinds of subsidy mechanisms that have been applied or proposed in each of the two categories and gives examples to illustrate the application of those mechanisms separately and in combination. Attention is directed to user-side subsidies, and, to the extent that existing knowledge permits, the advantages and disadvantages of this category are discussed. The conclusion is reached that user-side subsidies have substantial promise and warrant further investigation through a program of empirical analysis.

PROVIDER-SIDE SUBSIDIES

Provider-side subsidies are currently paid to most large transit systems in the United States. Implicit in nearly all public policy regarding transit services is the notion that a desired level of transit service cannot be achieved by a private operation for profit. Deficits, therefore, are met by direct payments from governments to providers. The large private transit system is nearly extinct; large systems are typically owned and operated by a public agency. Taxicab and limousine services, on the other hand, are always private businesses operated for profit.

Provider-side subsidies can take a variety of forms. A government agency might contract for equipment or services provided by private operators, or the agency might own the transportation equipment and facilities and employ people to operate the system. Several intermediate versions are possible. For example, the government agency can own the equipment and facilities and contract with a management company to operate the service, or it may employ drivers but contract for maintenance. The government, in principle, sets the standards and seeks cost-effective methods to achieve them. There is a vaguely defined acceptable gap between revenues and costs, and the subsidy ensures that the desired service standards and fare levels are maintained.

Until very recently, capital grants funded under the Urban Mass Transportation Act were the major federally sponsored provider-side subsidies to urban public transportation. Currently, such grants are available to public agencies and require 20 percent local matching funds. The grants must be applied for and are subject to upper limits set for each state. These grants have been used primarily for buses, terminals, and storage facilities and, in those places with rail transit, for rail equipment and facilities. Taxicab and other privately operated systems cannot receive these grants directly, although a local government body can set up an agency to own vehicles and facilities and contract with private companies to operate them or lease vehicles and facilities to private operators at less than market rates. The intent of Congress in establishing this program in 1965 was to preserve and upgrade existing public transit services by improving the condition of the capital equipment operated by transit providers.

In 1974 the act was amended to provide somewhat more limited funds for operating expenses; it requires 50 percent local matching funds (8). Funds for operating assistance are allocated by formula to large urbanized areas and states. Operating subsidies have also been provided to transit operators for some time from various state and local budget sources. By and large, the source of these funds is property taxes, though some areas have adopted sales taxes for a portion of such subsidies (2, 3).

Other examples of provider-side subsidies are special services for handicapped or low-income people subsidized with funds from social service programs. The provider in these cases is often the social service agency itself rather than a transit authority or taxicab operator. Experience with reduced transit fares for the elderly has been relatively widespread. A New York system (1) reported that users of the reduced fares are predominantly white and do not have low incomes, suggesting that groups that already travel are more likely to use the reduced fare system than are the more seriously disadvantaged who do not travel much at present. Programs for the handicapped are most frequently offered through social service agencies, although in recent years special facilities for the handicapped have often been provided by transit systems and by private operators. These special programs and facilities sometimes include specially trained drivers who assist the handicapped rider in entering and leaving the vehicle and special vehicles with devices such as wheelchair ramps and lifts.

Some special transportation programs for disadvantaged areas have also been provided from various federal, state, and local sources. These programs are oriented to the welfare of low-income persons in particular areas. Some of these have been federally encouraged programs for limited periods, as in Model Cities demonstrations, while others have been locally based programs funded on a more or less permanent basis.

USER-SIDE SUBSIDIES

In a few scattered situations, subsidies have been given directly to the user. The mechanism can be a voucher, a token, a ticket, a coupon, or a credit card in which part of the fare is paid by a public agency. These user-side subsidies are passed on to the provider only when the user is served and have the advantage of acting as an incentive for the transportation provider to "subsidy hunt" rather than to take subsidy for granted. They also have considerable flexibility. They can be varied by income, age, mode, class of service, time of day, and so forth.

Some existing examples of user-side subsidy applications illustrate the range of mechanisms that can be used.

1. In Los Gatos, California, elderly and disabled residents can purchase up to 10 taxicab tickets per month from the city at 50 cents per ticket and use these tickets at the rate of one per trip for taxicab travel anywhere within the city limits. The taxicab operator is paid $2.10 for each ticket he turns in to the city.
2. In an experimental program in Arlington County, Virginia, certain elderly residents were allowed to make taxi trips anywhere within the county for a flat user payment of 15 cents. The taxicab operator computed each fare by means of a taxi meter, and billed the county for the total fare less the 15 cents paid by the user.
3. In Danville, Illinois, the three local taxicab companies are participating in a user-side subsidy experiment funded by the Urban Mass Transportation Administration. Elderly and handicapped residents purchase shared-ride taxicab services from the provider of their choice by paying 25 percent of the regular fare and signing a voucher for the remainder of the fare. The taxicab operator then submits the voucher to the city and is reimbursed for the amount shown on it.
4. In Raleigh, North Carolina, some social service agencies subsidize taxicab services for their clients by means of a two-part ticket. On completion of a taxicab ride, the driver records the fare on both halves of the ticket and gives one half to the rider. The driver obtains

the rider's signature on the other half and submits that half to the social service agency for reimbursement. In this example, the rider pays nothing toward the fare. The social service agency covers the full fare.

The sale of tickets to users at reduced rates does not in itself constitute a user-side subsidy scheme. In El Cajon, California, for example, users buy 50-cent tickets and use them to purchase taxicab rides costing around $1.50, but the taxicab operator is paid by the city according to the occupied taxicab-kilometers of service provided rather than according to the trips made by the riders. And, in Joplin, Missouri, the city purchases $5 and $10 taxicab coupon books from the taxicab operator and then makes them available to low-income residents at a 70 percent discount. Thus the taxi operator gets paid for the tickets regardless of whether they are used. Because the payment to the taxicab operator is not related directly to each person trip actually made in these examples, these subsidy techniques fall into the category of provider-side subsidies.

User-side subsidy schemes need not involve the use of tickets, coupons, or credit cards. In the Arlington County experiment, reimbursement to the taxicab operator depends directly on the person trips made, though no tickets are used. In this case, tickets were used at the beginning of the program, but after a short period of operation it was decided that adequate accounting could be maintained without the use of tickets.

EVALUATION OF SUBSIDY PROGRAMS

The brief discussion of provider-side and user-side subsidies points to a number of general advantages and disadvantages associated with each category. Provider-side subsidies are relatively easy to administer but do not generate strong incentives for the provider to seek out ridership or to operate efficiently. On the other hand, although user-side subsidies are more difficult to administer, they encourage providers to tailor their services carefully to meet the needs of the groups receiving subsidy and to deliver those services as efficiently as possible. Some hypotheses about the relative merits of different subsidy programs are presented below, and these hypotheses are examined in the light of experience to date with urban public transportation subsidies. Where there is insufficient experience to test some of the hypotheses, we recommend additional data gathering and experimentation to fill the information gaps.

A community that decides to subsidize public transportation can disburse the subsidies in one of the following ways:

1. Through user-side subsidies alone,
2. Through provider-side subsidies alone, or
3. Through combined provider-side and user-side subsidies.

The likely implications of each of these approaches are discussed.

User-Side Subsidies Alone

The primary advantage of user-side subsidies is that they promote efficient use of transportation resources. By placing the subsidy funds in the hands of the users and forcing transportation providers to seek out the subsidy, public bodies can ensure that services are tailored to meet the needs of the users and that costs are carefully controlled. As long as providers are relatively free to enter the market and to set their own service levels and fares, the user-side subsidy approach should lead to efficient use of the transportation modes. Buses would not be used when taxicabs could provide better service at lower cost, for example. The user-side approach also frees public bodies from much of the service and fare monitoring necessary with provider-side approaches; the providers design service levels and fares that best serve the demand, just as food suppliers, for example, design their products and prices to serve their markets.

The major disadvantage of the user-side subsidy approach is probably administrative. The user-side mechanism requires a system for identifying users and reimbursing providers. Considerable effort is required to handle the tickets in such a way as to minimize fraud. Where subsidies are provided to only a small subgroup of the population, however, it may be possible to administer a ticket system conveniently as a component of a broader social service program.

Considerations such as these lead to the following general hypotheses about a program of user-side subsidies alone:

1. Users will obtain high-quality services from the providers;
2. The various public transportation alternatives will be used in an efficient manner;
3. Providers will operate their services efficiently; and
4. Some administrative difficulty may be experienced in distributing tickets and in guarding against fraud.

More specific hypotheses could be developed about the relative merits of different user-side subsidy mechanisms, but the discussion is kept at a general level in this paper.

Provider-Side Subsidies Alone

Various types of provider-side subsidies account for nearly all the public transportation subsidy programs currently operating in the United States. They typically accompany public ownership of the provider or a contract between a public agency and one provider for certain specified services. This subsidy approach is relatively easy to administer, but whether it provides incentives for economic efficiency is questionable. Provider-side subsidies, almost without exception, have reduced the degree of competition between providers and, indeed, have often resulted in the dependence of the public on a single provider.

Certain provider-side mechanisms appear to have contributed directly to inefficiency in provision of service. An analysis by Tye (7) concluded that the capital grant mechanism encourages premature replacement of capital equipment and inadequate maintenance. Hilton (4) contends that public ownership of transit systems has resulted in higher wage rates and operating costs than would have existed under private ownership. Finally, Kirby and others (5) suggest that restriction of capital grants to publicly owned transit systems has led to the use of public bus operators for some services that could be provided more efficiently by taxicabs or other private providers.

The following hypotheses evolve from experience to date with provider-side subsidies:

1. Administration of the subsidy funds is relatively straightforward;
2. Competition between providers is reduced, and costs of service rise more rapidly than they might with other subsidy approaches;
3. Those providers receiving the subsidies may be

overutilized while other providers are underutilized; and
4. Transportation providers receiving the subsidies are less responsive to local transportation needs than they might be with other subsidy approaches.

Although cogent arguments can be made and illustrations can be given to support these hypotheses, the empirical evidence currently available leaves some uncertainty regarding their validity. Further analysis is needed to test these hypotheses more completely.

Combined Provider-Side and User-Side Subsidies

It is possible for a community to disburse part of its subsidy budget through a provider-side technique, such as capital grants, and part through a user-side technique, such as reduced user payments for tickets redeemed for full value by the providers. The Transportation Remuneration Incentive Program (TRIP) in West Virginia is an example of this approach. Of the $21.9 million to be expended on this program during fiscal years 1974 through 1977, $8.8 million will be used to cover the cost of providing transportation tickets to eligible users at 45 percent of face value, and $7.7 million will be used to cover capital and operating costs for certain transportation providers (9).

The use of combined provider-side and user-side subsidies will have some of the advantages and disadvantages of both approaches. The community will have to deal with the administrative problems of the user-side subsidies as well as the efficiency problems created by the provider-side subsidies. It should be noted in particular that, if certain providers are favored over others when the provider-side subsidies are disbursed, the favored providers will have a competitive advantage in setting fares and consequently may be overutilized by both recipients of user-side subsidies and others. (This problem might be alleviated to some degree by allowing providers not receiving provider-side subsidies to redeem user-side tickets at a higher value than the other providers. Such an approach might create additional administrative difficulties, however.)

The following hypotheses have been developed regarding the use of combined provider-side and user-side subsidies:

1. Many more providers can be involved than in provider-side subsidies only;
2. Administration of the user-side funds may be difficult;
3. Those providers receiving provider-side subsidies may lose some of their incentives for efficient operation; and
4. Users, whether subsidized or not, may overutilize those providers favored by the provider-side subsidy scheme and underutilize other providers.

As a statewide program, TRIP provides an interesting case study of the use of combined provider-side and user-side subsidies, and should provide some guidance on the validity of the hypotheses.

EXPERIMENTS AND CASE STUDIES

A comprehensive examination of the hypotheses outlined above requires a program of empirical analysis of existing subsidy forms and well-designed experimentation with untried subsidy techniques. Although a variety of provider-side subsidy schemes can currently be observed in U.S. cities and, with considerable additional data collection, analyzed, experience with user-side and combined provider-side and user-side schemes is quite limited. Examples of the former category are limited to a handful of subsidy programs using taxicabs, and TRIP is the only known example of the latter category. Further examination and comparison of the three subsidy approaches discussed in this paper depend, then, on the development of experiments involving user-side subsidy techniques.

Table 1. Experiments and case studies.

Location	1970 Population	Type of Test	Type of Subsidy Program
Charleston, W. Va.	300 000	Case study	Provider-side and user-side (e.g., TRIP)
El Cajon, Calif.	62 000	Case study	Provider-side (city contracts with taxicab operator)
Joplin, Mo.	39 000	Case study	Provider-side (city buys tickets from one taxicab provider)
Westport, Conn.	27 000	Case study	Provider-side (capital grants, operating assistance for minibuses)
Danville, Ill.	43 000	Experiment	User-side (tickets with three taxicab providers, no bus providers)
Site to be selected		Experiment	User-side with minimal or no provider-side (tickets with taxicab and bus providers)
Pleasant Hill, Calif.	25 000	Case study	User-side (one taxicab provider)
Richland, Wash.	26 000	Case study	User-side (one taxicab provider)
Los Gatos, Calif.	23 000	Case study	User-side (one taxicab provider)
Arlington, Va.	174 000	Case study	User-side (one taxicab provider)

Under UMTA's Service and Methods Demonstration Program, a program of case studies and experiments is being designed and conducted to test the major hypotheses discussed. To date, these investigations have been confined to relatively small urban areas of less than 300 000 population where the costs of implementing and analyzing alternative subsidy schemes are not too great. Table 1 gives the areas currently being studied under this program.

Two experiments are being conducted; one (Danville, Illinois) has been in operation since November 1975, and the other is currently at the site selection stage. The Danville experiment provides an example of a user-side only program involving a number of taxicab providers; the second experiment will illustrate this approach by using bus as well as taxi providers. The case studies listed represent a variety of examples of the other two subsidy approaches.

Data from these experiments and case studies are being used to investigate the efficiency and administrative feasibility of these different subsidy approaches. These analyses will be combined with an overview of the various financing techniques available for public transportation to provide general recommendations for communities on the relative merits of alternative subsidy programs. Although these case studies and experiments are few in number and in some cases may not permit broad generalizations, they should contribute greatly to existing knowledge about public transportation subsidization and suggest ways in which broader conclusions could be obtained.

CONCLUSIONS

Provider-side and user-side subsidy mechanisms have been discussed and contrasted in this paper. Provider-side subsidies are likely to be easier and less costly to administer than user-side subsidies, but provider-side subsidies have often resulted in increased costs and in the dependence of the public on a relatively small number of providers and services.

User-side subsidies appear to be more efficient; when subsidies are in the hands of the users, they can choose those providers and services that best meet their needs. User-side subsidies rely, of course, on the willingness and ability of providers to supply adequate levels of service. Where there is a single operator and the appropriate level of service can be readily specified and costed, it may be simpler to assist the provider directly through a provider-side subsidy. If, on the other hand, there is a desire to provide a given level of subsidy to selected users and to allow providers to tailor services and fares to the demand, the user-side subsidy will probably be preferable. In some locations, a combination of provider-side and user-side subsidies may be appropriate. More empirical analyses, including experiments in selected locations, are needed to draw more precise conclusions regarding the relative effectiveness of these different approaches for subsidizing urban public transportation.

Virtually all of the financial assistance currently provided for urban public transportation is disbursed through provider-side subsidies. This paper suggests, however, that user-side subsidies might be more efficient for many applications. If further research confirms this hypothesis, policy makers should consider revising current subsidy programs to encourage the distribution of more funds through user-side subsidies. Such a change should lead to a more efficient mix of public transportation providers and services and permit more effective use of subsidy funds in achieving public policy objectives in urban transportation.

ACKNOWLEDGMENT

The preparation of this paper was supported by the Service and Methods Demonstration Program of the Urban Mass Transportation Administration, U.S. Department of Transportation. Opinions expressed in the paper are those of the authors and do not necessarily reflect the views of the Urban Institute or the sponsor.

REFERENCES

1. M. H. Cantor. Elderly Ridership and Reduced Transit Fares: The New York City Experience. U.S. Department of Health, Education and Welfare, 1970.
2. A. M. DeBeer. Financing Operating Subsidies for Urban Mass Transit Systems: An Analysis of State and Local Tax Options. National Technical Information Service, Springfield, Va., PB 239 634, 1974.
3. W. D. Hart. Public Financial Support for Transit. Highway Users Federation for Safety and Mobility, Technical Study Memorandum 7, 1973.
4. G. W. Hilton. Federal Transit Subsidies. American Enterprise Institute for Policy Research, Washington, D.C., 1974.
5. R. F. Kirby, K. U. Bhatt, M. A. Kemp, R. G. McGillivray, and M. Wohl. Para-Transit: Neglected Options for Urban Mobility. Urban Institute, Washington, D.C., 1975.
6. S. Myers. Turning Transit Subsidies Into "Compensatory Transportation." City Magazine, Summer 1972.
7. W. B. Tye. The Capital Grant as a Subsidy Device: The Case Study of Urban Mass Transportation. In The Economics of Federal Subsidy Programs: Part 6—Transportation Subsidies, U.S. Congress Joint Economic Committee, Feb. 26, 1973.
8. Urban Mass Transportation Act of 1964 and Related Laws. U.S. Department of Transportation, 1975.
9. TRIP Facts. West Virginia Department of Welfare, Charleston, 1974.

Abridgment

Preference Elasticities of Transit Fare Increases and Decreases by Demographic Groups

Elene P. Donnelly, Planning and Research Bureau, New York State Department of Transportation

Although research has been conducted to develop demand elasticities for transit at different fares, the literature is notably lacking in drawing a distinction between forward elasticities (fare increases) and backward elasticities (fare decreases).

The Curtin rule suggests a 33 percent decrease in ridership for each 100 percent increase in fare. In the 1974 transit operating assistance study done by the New York State Department of Transportation (1), three forward elasticities are reported: -0.25 for the New York City bus and subway and Buffalo bus systems; -0.55 for other bus systems; and -0.70 for commuter rail (2).

Although it is widely believed that the elasticity of demand is not the same for fare increases as for decreases, there is little evidence to support this contention because fare decreases rarely occur, and so data are lacking. Only intuition indicates that when a transit rider has forsaken a mode, for whatever reason, he is less likely to ride it again if the former conditions return.

A logical argument supports this belief. When a rider leaves the transit mode because of increased fare or decreased service, he usually turns to the automobile for transportation. If fares or services return to the former level, there is nothing to force him to return to transit. On the contrary, having made an automobile purchase, he is likely to continue to use it. Habit favors retaining the current mode until an outside force (e.g., cost or inconvenience) causes a personal reevaluation. That the Curtin rule does not hold for backward elasticities is noted by Holland (3) who offers some evidence that the increase in ridership for a 10 percent fare decrease is in the range of 10 to 30 percent.

This study investigates the nature of forward and backward fare elasticities of transit demand by various socioeconomic strata.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

TRADE-OFF ANALYSIS

Although demand information is lacking on backward fare elasticities, the issue can be addressed from a preference point of view. Presumably, knowledge of how people say they would change their transit ridership habits is an indication of how they would actually behave. Estimates of people's preferences for different transit programs that vary only in fare level may be translated into preference elasticities, which in turn may result in a relationship between forward and backward preference elasticities and therefore backward and forward demand elasticities.

The trade-off technique, in which the respondent compares two items by trading off one for the other, was used to study this issue. The willingness of the respondent to make this trade is recorded in matrix form and is later translated to ratio-scaled data.

When presented with a matrix (Figure 1) that displays the possible trade-offs, each respondent orders them, rating the most attractive (or least unattractive) as 1, the next as 2, and so forth. Each respondent ranks the trade-offs according to his or her personal preferences.

An algorithm exists that transposes simple rank order preference data, acquired through specially designed survey questionnaires, to ratio scales. The value on the scale for each variable for each respondent may be combined with other values for like variables for different respondents, to arrive at preferences of the entire population or for certain stratifications of the population. More matrices may be developed to allow comparison of several more features being considered in the given research project.

In December 1974, the New York State Department of Transportation sponsored a statewide public opinion survey incorporating some questions to be used for trade-off analysis (4). The data and trade-off analyses have been used to determine the elasticities of people's strength of preference for alternative operating assistance programs, as influenced by changes in fare.

Given a choice between fares of 25 cents and 30 cents, a person would logically choose the lower, all things being equal. The same response would be expected if he were asked to choose between 25 cents and $1.00. However,

Figure 1. Sample trade-off matrix.

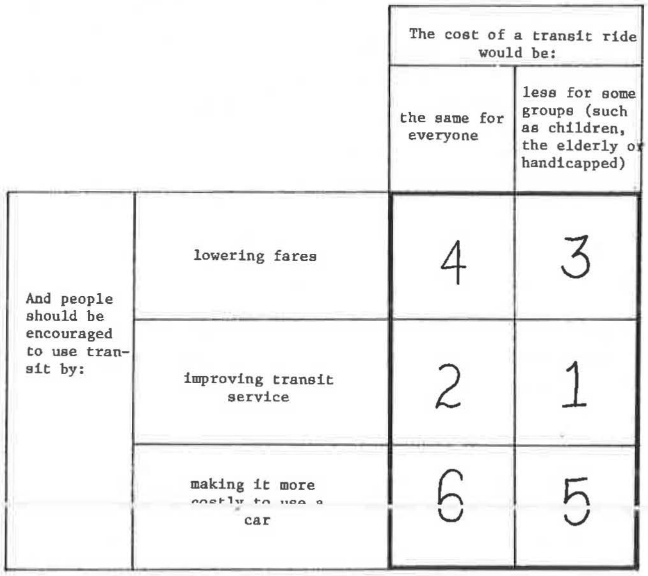


Figure 2. Preference elasticities.

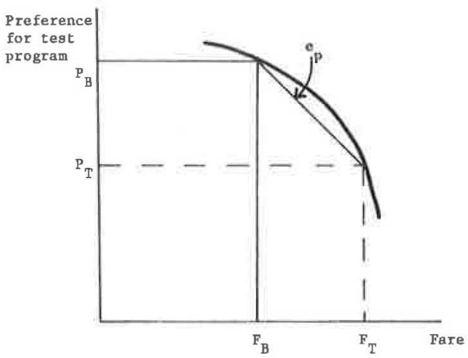
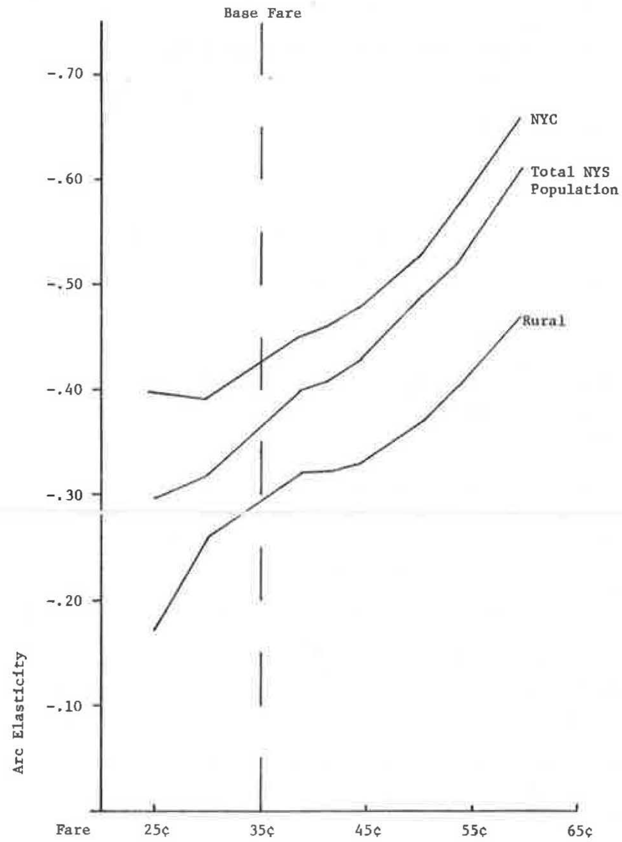


Table 1. Fare preference elasticities for fare decrease from 35 to 20 cents and fare increase from 35 to 50 cents.

Stratification	Lower Fare From 35 to 20 Cents	Raise Fare From 35 to 50 Cents	Ratio of Elasticities
Total population	-0.24	-0.49	2.04
Location			
New York City	-0.34	-0.53	1.56
Large metropolitan area	-0.18	-0.49	2.72
Small urban area	-0.14	-0.47	3.36
Rural	-0.12	-0.37	3.08
Age			
18 to 34	-0.22	-0.47	2.14
35 to 54	-0.16	-0.47	2.93
55 and older	-0.34	-0.53	1.56
Automobile ownership			
0	-0.44	-0.52	1.18
1	-0.16	-0.47	2.93
2 or more	-0.08	-0.47	5.88
Race			
Black	-0.26	-0.50	1.92
White	-0.23	-0.48	2.09
Other	-0.32	-0.52	1.63
Mode to work			
Automobile	-0.13	-0.39	3.00
Bus	-0.25	-0.62	2.48
Subway	-0.26	-0.44	1.69
Walk, other	-0.22	-0.49	2.23

Figure 3. Arc elasticities by fare.



that person's feelings toward a fare increase of 5 cents or 75 cents are not the same in both cases; the second increase would cause a much stronger reaction. It is this strength of reaction, not necessarily the direction, with which we are dealing here.

PREFERENCE ELASTICITY

The next step is, What is the difference in strength of reaction when the fare is increased 5 cents, 10 cents, and so on as opposed to decreasing the fare 5 cents, 10 cents, and so on? To answer this question, a preference comparison was made of the base transportation program against itself. As expected, the results in all stratifications indicated a 50-50 split in preference: Neither program was any better or worse than the other, so there was no difference in preference. A series of comparisons was then run of the base program and a second program that differed only in the average cost per ride (fare). In the comparisons, the base program was maintained while the fare in the new program was changed.

The preference scores from the trade-off runs were used to develop chord elasticities for fare decreases from 35 to 30, 25, and 20 cents and for fare increases from 35 to 40, 45, 50, 55, and 60 cents. These preference elasticities were computed by using the following method (Figure 2):

$$e_p = \frac{\%\text{ change in preference}}{\%\text{ change in fare}} = \frac{\Delta P/P_B}{\Delta F/F_B} = \frac{\Delta P}{P_B} \times \frac{(P_B - P_T)F_B}{(F_B - F_T)P_B}$$

where

e_p = preference elasticity,
ΔP = change in preference,

ΔF = change in fare,
P_B = preference for test program at base fare,
F_B = base fare (35 cents),
P_T = preference for test program at test fare, and
F_T = test fare.

GENERAL RESULTS

Table 1 gives the results for the New York State population as a whole and stratified by geographic area (New York City, large metropolitan areas of 500 000 population or more, small urban areas of 5000 to 500 000 population, and rural areas of less than 5000 population); age; automobile ownership or nonownership; race; and mode of transportation to work. For all stratifications, elasticity increases as fares are raised from about 35 cents (approximately the present rate). Likewise, elasticity decreases as fares are lowered from 35 cents (Figure 3).

The range of chord preference elasticities by stratifications for the 35 to 20-cent fare reduction is -0.08 to -0.44 and -0.24 for the total population. This is in striking contrast to a range of -0.39 to -0.62 for the 35 to 50-cent fare increase and -0.49 for the total population (Table 1).

Presumably, people react to a situation in accordance with their preferences. If people's preference for transit decreased, they would probably use transit less and vice versa. For example, if people's preference for a transit program decreased by about 14 percent when the fare is increased from the present level by 20 cents (in this case, from 35 to 55 cents), it can be assumed that transit ridership would decrease. When the fare is decreased by 20 cents from the present level (in this case, from 35 to 15 cents), people's preference increases by only 6 percent. Presumably, the percentage of change in ridership here would be less than that for a 20-cent increase, since the change of preference for the decrease is much less than the change in preference for the increase.

RESULTS BY STRATIFICATIONS

The change in preference elasticity is not the same for all groups of population (Table 1). For those who have no alternative to transit, the fare elasticity at low fare levels is much greater than for those with alternative modes available. A good example is New York City residents compared to residents of the other three geographic stratifications or those who do not own cars compared to both groups of car owners. Bus and subway riders react in the same way: Both groups are more sensitive to fare decreases than those who commute by automobile. Fare elasticity increases with fare. However, there is not a great difference among the three age groups, although automobile and bus users react in the extreme to fare increases (automobile users, the least of any group; bus users, the most of any group). In almost all of the stratifications, the differences appear in reactions to fares below the current rate; elasticities toward higher fares are nearly the same.

CONCLUSION

In all stratifications, the preference elasticity is significantly higher for fare increases from 35 to 50 cents than for fare decreases from 35 to 20 cents. Because these are preference elasticities, not demand elasticities, the results may not be directly applied to existing ridership and fare condition. However, the ratio of the forward preference elasticity to the backward preference does offer the opportunity to roughly estimate backward demand elasticities where the forward demand elasticities are known. Although this may produce only order-of-magnitude results, it is significant that these results will vary greatly from the known forward elasticities.

Backward elasticities not only are notably lower than forward elasticities but also differ more among various stratifications. Data given in Table 1 show that the preference responses by stratification for fare increases are much closer than are the responses for fare decreases, with the exception of the mode-to-work category.

All stratifications but one are almost equally sensitive to fare increase but have varying strengths of preference for fare decreases. Sensitivity to transit fare increases is significantly higher than sensitivity to transit fare decreases: People may become very unhappy about fare increases but may be only somewhat pleased about fare decreases.

REFERENCES

1. Public Transportation Operating Assistance: Evaluation and Options. New York State Department of Transportation, Summary Rept., Jan 1975.
2. Evaluations and Recommendations for Transit Operating Assistance. New York State Department of Transportation, Preliminary Draft, Dec. 2, 1974.
3. D. K. Holland. A Review of Reports Relating to the Effect of Fare and Service Changes in Metropolitan Public Transportation Systems. U.S. Department of Transportation, June 1974.
4. E. P. Donnelly and others. Statewide Public Opinion Survey on Public Transportation: Technical Report. New York State Department of Transportation, Preliminary Research Rept. 80, June 1975.

Analysis of State Transit Funding Methodologies

Brent O. Bair, Institute of Urban and Regional Research, University of Iowa
Douglas J. McKelvey,* Transportation Institute, North Carolina A&T State University

For several years, there has been growing pressure for state governments to become involved in the provision of technical and financial assistance to transit systems in their states. Many states have already responded with formation of state departments of transportation, legislation to assist transit, and assumption of responsibility to improve transit services through coordinated, comprehensive planning and financial assistance (1).

For those states not yet involved in providing assistance for transit operations, a major question is how to allocate those funds, given that there are various objectives to be met. This paper reviews state funding methods that may result in efficient, effective, and equitable transit service.

REVIEW OF STATE FUNDING OF TRANSIT

The following summary is based on a survey of 22 states that have departments of transportation. Each responded to a questionnaire concerning state assistance for public transit. The states were asked to identify the purpose, modes, recipients, allocation formulas, funding sources, and other relevant information related to state transit funding. Some of the information obtained is given in Table 1 (2).

The states explicitly allow the following uses of state funds:

Use	Number of States	Use	Number of States
Capital expenditures	17	Planning	6
Technical studies	10	Evaluation	3
Operating costs	9	Promotion	2
Demonstrations	7		

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

*The research reported in this paper was conducted while Mr. McKelvey was a research coordinator at the Institute of Urban and Regional Research, University of Iowa.

Almost every state surveyed uses state funds as matching funds for federal capital grants and to assist in the purchase of other transit property. Very few have allocated state funds for the evaluation or promotion of transit service. Eligible modes include fixed-route, demand-responsive, jitney, taxi, and rail. Most states provide assistance to fixed-route transit systems (17), and only a few states make funds available to jitney or taxi services (if sponsored by a transit authority). About half of the states (10) fund rail, and about one-third of the states (7) fund demand-responsive systems. As expected, the publicly owned systems were most eligible for funds (16).

ALLOCATION CRITERIA

The criteria by which states allocate funds for public transit vary considerably. The first major distinction in funding is between that allocated to areas and that allocated to systems. California, for example, allocates transit funds to an area based on that area's population. Usually those areas are planning subdivisions (county, multicounty, or metropolitan areas). State funds are allocated to systems primarily according to whether the funds are intended for operating or capital assistance.

The most common form of state assistance is for capital equipment and related transit property purchases. The amount of state contribution is directly related to the absence of federal money. A state will contribute from 25 to 100 percent of the nonfederal share. If a project or system is not requesting or is not eligible for federal assistance, then the state will provide usually 15 to 100 percent of the match.

If the state provides operating assistance, allocation is usually based on the system's deficit or the system's performance. Eligibility varies by ownership and type of service. Maryland completely subsidizes the operating deficit of the Baltimore public transit system and others on a discretionary basis; Delaware completely subsidizes a special system for agency-approved elderly and handicapped, and the state of New Jersey completely subsidizes the operating deficit of its public transit systems. Connecticut has two basic goals: to maintain existing transportation services and to provide incentives

Table 1. State funding of public transit.

State	Uses	Annual Amount ($)	Modes	Recipients	Allocation Criteria
California	Capital, operation, technical study, planning, promotion, demonstration	94 000 000	Fixed-route, dial-a-ride, rail	Public system, private nonprofit, private system, government	Population
Connecticut	Capital, operation, technical study, planning, promotion, demonstration	14 000 000	Fixed-route, dial-a-ride, rail	Public system, private nonprofit, urban	50 to 100 percent of deficit
Delaware	Capital, operation, technical study	4 000 000	Fixed-route	Public system, government	80 percent for DART
Florida	Capital, technical study, planning, evaluation, demonstration	6 700 000	Fixed-route, dial-a-ride, jitney, rail	Public system, public agency, government, urban, rural	50 percent non-federal
Georgia	Capital, technical study, promotion	400 000	Fixed-route	Public system	50 percent non-federal
Hawaii	Capital	300 000	Fixed-route	Government	
Illinois	Capital, operation, technical study, evaluation, promotion	171 000 000	Fixed-route, rail	Public system, private nonprofit, private system, urban, rural	⅔ of deficit
Kentucky	Technical study, planning, promotion	200 000		Public agency, government, urban, rural	50 percent non-federal
Maryland	Capital, operation		Fixed-route	Public system, government	100 percent for Baltimore
Massachusetts	Capital, operation	67 000 000	Fixed-route, rail	Public system, private nonprofit, private system, urban, rural	50 percent of deficit
Michigan	Capital, operation, promotion, demonstration	20 000 000	Fixed-route, dial-a-ride	Public system, government, urban	Vehicle-kilometers, population
New Jersey	Capital, operation	49 000 000	Fixed-route, dial-a-ride, rail	Public system, private nonprofit, private system, urban, rural	50 percent capital, 100 percent operation
New York	Capital, operation	103 000 000	Fixed-route, dial-a-ride, rail	Public system, private system, public agency, urban	Vehicle-kilometers, passengers
Ohio	Capital, demonstration	2 800 000	Fixed-route	Public system, private nonprofit	25 percent non-federal
Pennsylvania	Capital, operation, technical study, planning, promotion, demonstration	90 000 000	Fixed-route, dial-a-ride, rail	Public system, public agency, government, urban, rural	50 percent capital, ⅔ of operation
Tennessee	Capital, technical study, promotion	250 000	Fixed-route	Public system, public agency, urban	25 to 50 percent of deficit
Virginia	Capital, technical study	5 400 000	Fixed-route	Public system	
Wisconsin	Operation, demonstration	7 000 000	Fixed-route, dial-a-ride	Public system, private nonprofit, private system, public agency, government, urban	⅔ of deficit

for improving service. It subsidizes 100 percent of the operating deficit for a basic service and up to 50 percent for services above the basic level.

The other major criterion by a state allocates operating assistance for transit based on the system's service or performance. Michigan allocates 25 percent of its funds based on the number of transit kilometers of the system (3 demand-responsive kilometers are equivalent to 1 fixed-route transit kilometer). The allocation of another 25 percent is based on the system's eligible population (in the service area). New York State provides assistance based on mode, number of passengers, and number of vehicle-kilometers. Pennsylvania subsidizes operating assistance based on 3 cents/passenger-kilometer (5 cents/passenger-mile) rather than on vehicle-kilometers. This was chosen because of variations in trip length. (The total sum of Pennsylvania's subsidy may not exceed two-thirds of the operating deficit.)

ALLOCATION LIMITATIONS

In general, very few states place requirements on the allocation of state funds. In fact, only five of the 22 states identified special requirements governing who receives state assistance, how much, or for what purpose. California requires that 15 percent of the state transit funds go for capital purchases. Further, it requires that the total amount an area receives be equal to sales tax revenue generated from that area. Michigan requires that there be half fares for elderly and handicapped, that there be a state-approved transportation plan, and that school trips not be eligible for reimbursement. In Wisconsin, a system must have been in existence before August 5, 1973, and the recipient must be an eligible public body.

FUNDING SOURCES

There are seven sources of state funding for transit:

Source	States
General sales tax	California, Illinois
Bonds	Connecticut, Illinois, Massachusetts, New Jersey
Transportation fund or general revenues	Connecticut, Kentucky, Maryland, Massachusetts, Pennsylvania, Wisconsin
Gasoline tax	Florida, Hawaii, Maryland, Michigan
Motor vehicle registration	Illinois, Maryland
Cigarette tax	Massachusetts
Lottery	Pennsylvania

In Pennsylvania, funds from the lottery are used to subsidize the free-fare program for the elderly.

The most common sources of funds for public transportation are general revenues or a general transportation fund and gasoline tax (3). No single source is sufficient, and therefore states rely on a combination of the sources identified. In general, most of the sources of funding represent a form of cross subsidy from automobile to transit and from higher income to lower income.

SUMMARY

The results of the survey suggest the following trends.

1. Those states that have departments of transportation already have or have proposed legislation to

obtain state funds from existing tax sources or from general revenue for transit assistance.

2. Depending on the state, these funds may be used for capital assistance, operating assistance, demonstration, planning, evaluation, or technical study.

3. State funding for transit varies from $30 000 to more than $170 million.

4. Fixed-route transit systems are most likely to receive assistance, and private taxi services are least likely.

5. State assistance is provided almost exclusively to urban systems and less often to rural or intercity systems.

6. The major criterion by which states allocate their funds for capital assistance is usually the absence or presence of federal funding.

7. The proportion a state will provide for operating assistance depends on the system's deficit or performance. States contribute between 50 and 100 percent of a system's deficit, subsidize the system at a fixed rate for each passenger or vehicle-kilometer, or do both.

8. The transportation goals most stressed are the desire to maintain existing levels of service and fares and to provide an incentive for improved service.

ALTERNATIVE ALLOCATION METHODOLOGIES

If it is assumed that state operating assistance is warranted, three possible approaches might be taken. First, the state might provide direct or unfettered assistance whereby funds are simply passed through to the local governmental bodies with the assumption that the money will be spent to improve the transit service. The second approach is to regulate the provision of transit services and require the provision of minimum levels of service in order to obtain state funding. The final method is to provide a "carrot on a stick" or incentive program whereby local areas can obtain more money by improving the performance of their transit system. Based on a review of the potential of these alternative approaches and the methods actually used by the state, the incentive method is the most desirable because it provides a means of ensuring that various transit goals and objectives may eventually be met.

Obviously, state operating assistance is only one type of financial assistance important to the initiation, provision, or improvement of transit service. Other types of financial assistance for capital expenditures, planning, evaluation, and demonstrations are also important. Also, state-level funding alone is not sufficient to ensure equitable, efficient, or effective transit service. However, through the incentive program, measures of equity, efficiency, and effectiveness may be built into the allocation methodology so that future improvements are in fact guided through the funding mechanism (4).

After a very preliminary review of various allocation criteria based on population, percentage of deficits, passenger trips, route-kilometers, vehicle-kilometers, and various ratios such as passengers per vehicle-kilometer, the following initial observations may be drawn.

1. The allocation criterion of passenger trips is the only single criterion that may result in greater equity, efficiency, and effectiveness of service.

2. The bases of population and percentage of deficit appear, by some measures, to be the least desirable criteria by which to allocate operating assistance, although politically they may be among the easiest to initiate.

3. The criteria that are stated in terms of the trips per capita, kilometers per capita, kilometers per service area, or other combinations seem to have very few advantages over the single criteria of route-kilometers, vehicle-kilometers, or passenger trips.

4. No single criterion will be both appropriate to increasing equity, efficiency, and effectiveness and practical and politically acceptable for allocating funds.

5. Any allocation criterion or combination of criteria should include the requirement that the assistance be used first to achieve minimum standards and then to improve service above those standards.

It is suggested that an allocation methodology should consist of more than one criterion. The criteria should include a simple measure of system performance or supply; measures of demand that are sensitive to the type of demand by person, trip purpose, or some similar characteristic; and some measure that reflects system efficiency. There would necessarily be some weighting of these various parts of the formula. That weighting should not be uniform among states but should be adjusted to reflect local conditions.

CONCLUSION

Review of the allocation methods currently in use by state departments of transportation indicates that most of the methods were probably initiated because of political acceptability rather than their effectiveness in addressing particular transportation objectives. There is little question that in many cases any type of financial assistance will help, but it may be possible to accomplish more than simply bailing transit systems out of financial crises. Through the proper selection of an allocation formula, it may be possible to guide or encourage many desired improvements. It is clear that more research is needed in this area.

REFERENCES

1. E. R. Gerlach. Transit Operating Subsidies—1974. Proc., Fifteenth Annual Meeting, Transportation Research Foundation, Vol. 15, No. 1, 1974.
2. B. O. Bair and D. J. McKelvey. Current State Practices in Transit Funding. Institute of Urban and Regional Research, Univ. of Iowa, Technical Rept. 63, July 1975.
3. A Study of Urban Mass Transportation Needs and Financing. U.S. Department of Transportation, July 1974.
4. H. A. Levine. Evaluation of the Procedures for Allocating Operating Deficits From Urban Transit Systems. Proc., Fifteenth Annual Meeting, Transportation Research Foundation, Vol. 15, No. 1, 1974.

Procedures for Financial Analysis of Transit Operating Assistance Grant Requests

William C. Underwood, Bureau of Mass Transit Systems, Pennsylvania Department of Transportation
John C. Bennett and James M. Holec, Peat, Marwick, Mitchell and Company

The increasing reliance of transit operations on financial support has caused funding agencies to begin to evaluate the operating expenses of transit operators seeking financial assistance. One possible evaluation approach involves comparing aggregate expense estimates of individual transit properties with industrywide performance. This paper reports on the development of an evaluation framework that uses this approach. The evaluation technique is discussed, and specific administrative actions are illustrated in response to the operating expense performance of individual operators.

During the last 3 decades, the transit industry has experienced a general financial decline from an industrywide net income in 1945 of $313 million to an industrywide deficit in 1975 (preliminary estimate) of $1663 million (1). This decline has been attributed to a set of related causes that include

1. An increase in use of the automobile, which caused initial patronage losses and revenue decline;
2. An industry reaction of fare increases and service reductions, which led to greater losses in patronage and revenue; and
3. The recent rapid increase of transit operating expenses.

Accompanying this general decline has been an accelerating trend toward public ownership of transit systems and an increasing involvement in the direct financial assistance of transit operations by local, state, and federal governments. By 1972, local assistance to transit amounted to $545 million (approximately 60 percent for operating subsidies), state assistance reached $177 million (also 60 percent for operating subsidies), and federal assistance amounted to $470 million (all for capital improvements) (2). In addition, as of November 1974, the federal government made a commitment to assist transit systems with direct operating subsidies through passage of the National Mass Transportation Assistance Act of 1974.

Although this broad program of financial assistance has, in general, improved and expanded public transportation services, it has also resulted in an alarming consequence. Evidence suggests an increasing reliance of transit operations on public financial support.

As reported in the 1974 National Transportation Study, operating and maintenance costs for the transit industry are expected to increase 276 percent from $2.6 billion in 1972 to about $7.2 billion in 1990 (3). These estimates are reported in 1971 constant dollars and do not, therefore, account for escalation resulting from general inflationary trends. In the face of these increasing operating expenses, transit operators across the nation have been attempting to follow a policy of fare stabilization. (This intention has been moderated somewhat as evidenced by a fare increase in Washington, D.C., and similar fare hikes in New York City and other major metropolitan areas facing financial difficulties more pervasive than those represented by transit alone.) Together, these trends imply an expected sixfold increase in annual net operating deficits from $0.4 billion in 1972 to $2.5 billion in 1990 (3). This trend is likely to be reinforced with the establishment by the U.S. Department of Transportation of a multibillion dollar public transit operating assistance program. Under Section 5 of the National Mass Transportation Assistance Act of 1974, operating assistance grants are being approved even though there is virtually no means of evaluating the efficiency of a transit system in relation to quality and quantity of service provided.

Mounting deficits will, at least, focus public attention on the operational efficiency of individual transit systems. Most likely these deficits will also become catalysts for broad public policy discussions of the benefits of public transportation versus the benefits of private automobiles, the proper mix of transit and automobiles in urban communities, the total costs of each modal alternative for different modal mixes in different urban environments, and the appropriate financing mechanisms for transit investment and operation.

TRANSIT OPERATING ASSISTANCE IN PENNSYLVANIA

In 1967, Pennsylvania enacted the Pennsylvania Urban

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Mass Transportation Assistance Law authorizing one of the nation's first urban public transportation assistance programs to offer financial assistance for the operating expenses of transit properties. This legislation was recognized as a response to the poor financial condition of the two largest transit operators in the state. Therefore, budgeting and distribution of funds for the program were straightforward, and the criterion for assistance was need. The only limitation was that the state's contribution cannot exceed two-thirds of the deficit.

Since 1967, however, the scope of this assistance program has broadened significantly. Now the Pennsylvania Department of Transportation receives grant requests from more than 20 operators, and individual requests range from $1500 to more than $40 million per annum. In 1974-75, the Pennsylvania DOT approved $74.2 million worth of public transportation assistance grants, most of which were used for transit operating assistance. In comparison, when the Pennsylvania DOT was created in 1970, its public transit operating assistance budget was less than $11 million. Accompanying this increase in the scope of financial assistance has been a trend toward greater state involvement in efforts to improve both the level and quality of transit services and the efficiency of transit operations.

This involvement has resulted in a need for more accurate and detailed information regarding the financial and operating performance characteristics of individual transit operators. The effort to establish and monitor standards of transit performance requires the periodic flow of financial and operating statistics from each transit operator receiving state assistance. Evaluation of these financial and operating data requires procedures and guidelines for measuring the validity of expense estimates submitted by individual transit operators and the quality of transit service provided by these operators.

To measure the quality of transit service in Pennsylvania, standards and guidelines of performance for transit systems receiving state transportation assistance grants were developed and implemented. In 1973, Pennsylvania established an operating evaluation program (4), which included specification of precise service standards, a standardized transit operating data reporting system, and a quantitative procedure for evaluating public transit operations and services (5).

To evaluate the financial efficiency of transit operators, the Pennsylvania DOT is introducing a program that compares the aggregate expense estimates of individual transit properties with industrywide performance. This paper reports on the development of this financial evaluation framework.

GRANT EVALUATION PROCEDURES

The review of an application for transit operating assistance should include financial, operational, and legal or administrative evaluation procedures. Although separation of the financial, operational, and legal and administrative characteristics of transit systems is not precise, it is convenient to distinguish each of these three categories when individual grant applications are evaluated. The procedures that have been developed specifically for the financial evaluation of requests for operating assistance submitted to the Bureau of Mass Transit Systems are described below.

Overview of Evaluation Procedure

To analyze operating assistance grant requests, the Pennsylvania DOT has adopted a set of application and reporting forms that use the major categories of the Interstate Commerce Commission (ICC) expense reporting framework. In addition, in anticipation of federal reporting requirements, these ICC expense reporting categories have been defined in terms of the function-object code classification developed as part of the financial accounting and reporting elements (FARE) project (6).

Financial evaluation of grant applications is based on an assessment of the reasonableness of expense estimates included in the grant request made by the transit operator. The key to this analysis is a set of guidelines that express the relation between transit operating expenses and transit operating and financial characteristics.

Equipment maintenance and garage expenses, for example, may be related to the level of system operation (as measured by vehicle-kilometers operated) and the wage rate of maintenance personnel. Transportation expense may be related to the hours of system operation and the wage rate of transit operating personnel. Equations based on simple relations such as these may be developed to explain most of the variation in the aggregate operating expense performance of individual systems throughout the transit industry.

After expenses have been estimated, guideline relations for major expense categories permit reasonableness of expense estimates to be determined. Large expenses inappropriately allocated to cost categories may be detected at the outset of the financial evaluation process. If all expenses are based on allowable costs properly categorized into appropriate accounts, guideline analysis should detect inefficient levels of expenditures in relation to transportation service.

If unreasonable expenses are detected, further investigation is initiated. Unallowable costs in an expense category constitute one potential cause for unreasonable expense estimates. Although the investigation of this cause would not be complete without an audit, large-magnitude violations in expense categories may be attributed to this factor through a review of more detailed information, which may be requested of transit operators.

Another potential cause for unreasonable expense estimates results from either inefficient production of transit services or justifiable localized effects that are not accounted for in the guideline relations. An attempt should be made to verify that the guideline relations are applicable to the transit operator exhibiting unreasonable expense estimates. This too may be accomplished through evaluation of more detailed information. If it is determined that the guideline relations are in fact applicable, the questionable expense performance of the individual transit operator would result in administrative action.

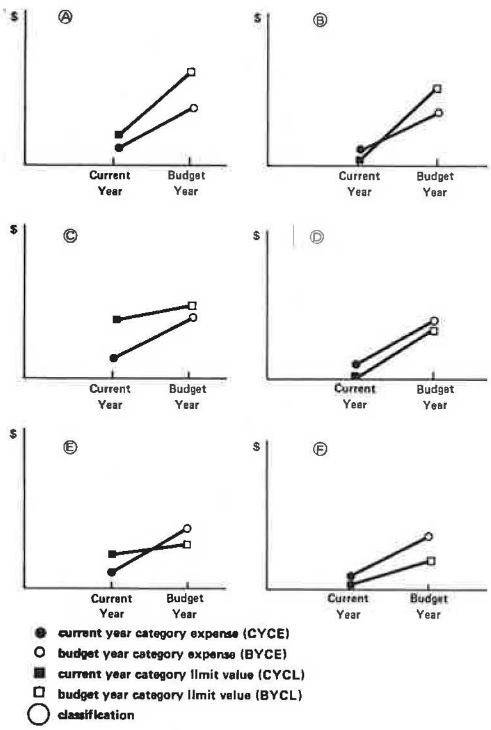
Application of Financial Guidelines

Financial analysis of operating assistance grant requests can be performed at two levels. The guideline relations may be used to ascertain the reasonableness of budgeted expense levels and of incremental expense levels between the current year and the budget year. The evaluation of transit operations expenses is initiated when guideline relations are used to calculate limit values for each major category of cost, and comparisons are made of the cost estimates submitted by the transit operator and these limit values. The limit value is a standard that is based on the aggregate statistics used to describe the operating character of each property and on the guideline relation between major cost categories and the aggregate statistic. Evaluation of incremental expenses involves comparing the estimated change in expense levels from the current year (based on the operator's own expense estimates) and the expected change in expense levels from the current year (based on the calculation of current year and a

Table 1. Performance classifications.

Classification	Exceeded Limit Value? Budget Year	Current Year	Rate of Change	Comment
A	No	No	<1.0	Excellent
B	No	Yes	<1.0	Costs controlled
C	No	No	>1.0	Potential future problem
D	Yes	Yes	<1.0	Current problem moving toward solution
E	Yes	No	>1.0	Emerging problem
F	Yes	Yes	>1.0	Continuing problem showing no signs of improvement

Figure 1. Performance classification for an individual expense category.



budget year limit value).

In the first step of the process, the limit for each major cost category is calculated for the budget year based on the financial and operating statistics submitted as a part of the operating assistance grant request. The second step involves the calculation of the limit values of cost for the current year's operation.

After the limit values for each cost category are determined, these values are compared with the operator's own expense estimates, and the rate of change reported by the operator is compared with the rate of change indicated by the limit values. This latter comparison provides the greatest insight into the relative performance of individual operators. The relative rate of change is calculated as follows:

$$ROC = \frac{BYCE}{CYCE} \Big/ \frac{BYCL}{CYCL}$$

where

ROC = rate of change,
BYCE = budget year category estimated expense,
CYCE = current year category actual expense,
BYCL = budget year category limit value, and
CYCL = current year category limit value.

Values greater than one indicate that the applicant's costs are rising faster than guideline values; if they are less than one, they are rising slower than guideline values.

Based on these three comparisons, an applicant's performance for a given expense category may be rated according to one of six classifications. These classifications, in increasing order of problem severity, are given in Table 1 and shown in Figure 1. Classification A indicates ideal performance. The operator is within limit values for both the budget and current years, and his incremental expense increases (if any) is lower than the guideline limit growth. Classification B also indicates good performance. In this case, the operator exceeded a limit value in the current year but has been able to control costs to below the limit value for the budget year. (By definition, his rate of change is less than one.) Classification C indicates a potential future problem in that, although both the current year and budget year limit values have not been exceeded, there is a trend toward higher costs, which may present a problem. Classification D represents a continuing problem that shows signs of solution because of a reduced incremental cost increase. Classification E shows that the applicant has exceeded the budget year limit value although in the past he was below the limit, indicating an emerging problem in this situation. The most severe condition is indicated in classification F. Both current year and budget year limit values have been exceeded, and the rate of change indicates an accelerating problem. Such a problem would warrant close attention by management.

Administrative Action

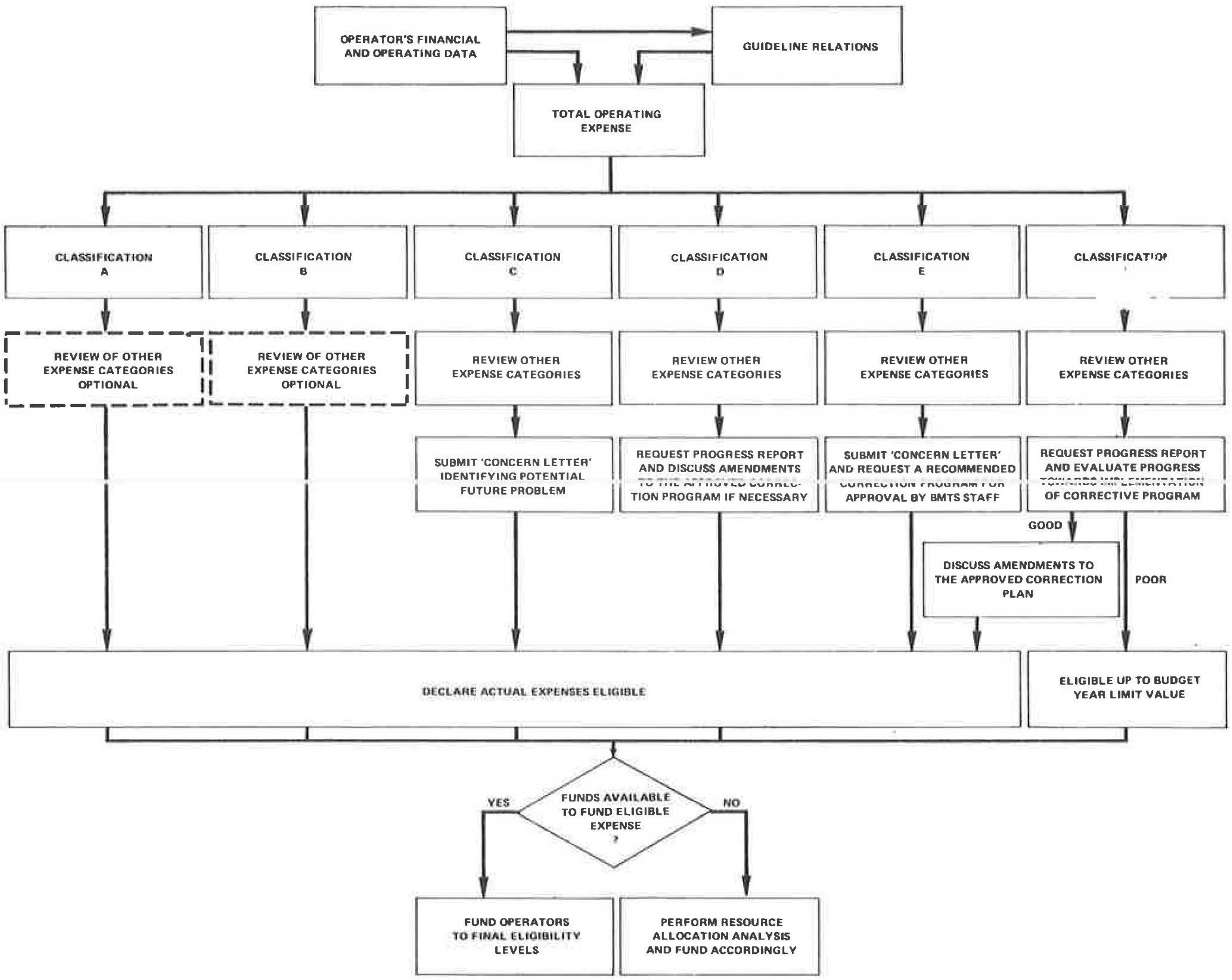
Subsequent to the calculation of limit values and the classification of the financial performance of individual transit operators, specific administrative actions would be taken. The administrative actions associated with the financial performance evaluation of transit operators in Pennsylvania are based on the following underlying principles:

1. The provision of transit services satisfies an important public need in the state;
2. Existing transit operations may provide services inefficiently for many reasons, some of which are not easily remedied by simple corrections to the production process; and
3. The purpose of the state's operating assistance program is to assist in the provision of efficient and effective public transportation services.

Together, these principles support a range of administrative actions that emphasize corrective rather than punitive intervention by the state. These actions are shown in Figure 2, which details the state's operating assistance review procedures.

As shown in Figure 2, transit operators submitting grant requests that have been evaluated and classified as either A or B require neither corrective nor punitive administrative action. These transit operators provide transit services at a reasonable level of expense in relation to the financial and operating characteristics of their systems. The only action required is the declaration of the actual expense estimates of these operators

Figure 2. Financial review procedures.



as eligible for grant determination (subject to verification by audit).

A transit operator receiving a classification C expense performance evaluation represents a situation in which both budget year and current year expense estimates fall within the limit value, but the rate of change is greater than one, indicating an extraordinary rate of increase in expense. This situation serves as a warning that a future problem may emerge. Consequently, the administrative action for this situation involves notifying the operator (by a letter of concern) that a potential problem was indicated in a review of his grant request. Classification C operators would then have their actual expenses declared eligible because they have not exceeded the limit value established by the guideline relation. The classification E expense performance illustrates the situation in which a transit operation has moved from a potential problem to a current, identified problem. In this situation, both the rate of change and the budget year expense estimates indicate unreasonable changes in the cost experience of the operator. This situation would be followed by administrative action as follows:

1. A concern letter is submitted to the operator indicating that, as a result of the review of the grant request, a problem has been observed;
2. The transit operator is requested to submit a recommended correction program for approval of the Pennsylvania DOT; and
3. The operator's actual expenses are declared eligible after the correction program has been approved.

A transit operator that receives classification D represents a property that has a current, identified problem and is moving toward a solution. Although both budget year and current year expense estimates exceed the limit values, the rate of change estimate is less than one, indicating that the cost experience of this operator is converging on the limit value. An operator in this situation will already have an approved program of corrective action. Therefore, the administrative actions resulting from this classification include a request for a progress report and consideration of possible amendments to the correction program as necessary. Because such an operator is making progress toward meeting the financial guidelines of the Pennsylvania DOT, actual expenses would be declared eligible.

As previously indicated, classification F represents the situation of most concern to the Pennsylvania DOT. In this circumstance, a continuing problem exists, which shows no signs of evident improvement. An operator in this category would already have an approved program of corrective action. An operator currently placed in classification F would have been in either classification D or

E during the previous year. Both of these classifications require that an improvement program be on file. Therefore, the first action required in this situation is to evaluate the operator's progress toward implementing the corrective program. If the operator has made a significant effort to adopt the recommended corrective program and the problem shows no signs of improvement, an amended correction plan should be considered. A concerted effort by the operator to improve the efficiency of transit service production according to the approved plan should result in a declaration of actual expenses as eligible. If, on the other hand, the operator has made no effort to adopt the provisions of the corrective plan, expenses would be declared eligible up to the budget year limit value only. This is the only situation in which administrative action includes the imposition of a policy constraint on expense eligibility.

Having determined the level of expense eligibility for all transit operators submitting requests, the Pennsylvania DOT approves operating assistance grant requests according to the availability of financial resources. If sufficient funds are available, the Pennsylvania DOT provides funds to operators to the final eligibility levels determined in the review of grant applications. If, however, funds are insufficient, the Pennsylvania DOT analyzes resource allocations and provides funds according to the results of this analysis.

CONCLUSION

With the development and implementation of these financial guidelines and evaluation procedures, the Pennsylvania DOT will have established a comprehensive program to (a) collect and analyze transit operating and financial data on a uniform basis; (b) measure the performance of transit systems seeking state operating and capital assistance grants; and (c) determine the allocation of state public transit grants based on the transit agency's operating and financial performance and the availability of funds.

This program should prove to be an effective approach in assisting to improve and expand public transit services and operations throughout Pennsylvania.

REFERENCES

1. 1975-76 Transit Fact Book. American Public Transit Association, March 1976, p. 26.
2. A Summary of Financial Assistance for Transit Systems in 1972. American Transit Association, June 1973.
3. A Study of Urban Mass Transportation Needs and Financing. U.S. Department of Transportation, July 1974, pp. III-32, III-39.
4. Operating Guidelines and Standards for the Mass Transportation Assistance Program. Pennsylvania Department of Transportation, Jan. 1973.
5. V. R. Vuchic, E. L. Tennyson, and W. C. Underwood. Application of Guidelines for the Improvement of Transit Service and Operating Efficiency. TRB, Transportation Research Record 519, 1974, pp. 66-72.
6. Project FARE Task IV Report: Urban Mass Transportation Industry Financial and Operating Data Reporting system. Arthur Anderson and Co., Washington, D.C., Nov. 1973.