AN ANALYSIS OF PRICE-SUBSIDY ISSUES IN PUBLIC TRANSPORTATION AND SOME SUGGESTIONS OF PRACTICAL IMPORTANCE

by

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ABSTRACT

This report is directed to highway and transportation officials and other state and local government officials faced with questions of public transit subsidies. The questions are very real ones and, in this one's opinion, require well founded answers.* By means of this exposition, the author provides the above audience with several conclusions, recommendations and analytical points of view which are of practical importance.

First, the author establishes that the great majority of arguments usually offered in support of subsidization are weak and unfounded. Whereas two economically justifiable arguments can be identified, their validity depends upon empirical proof that significant long-run average cost reductions arise through increased ridership. Secondly, the report provides an explicit set of criteria which are useful in judging alternative subsidy mechanisms by their ability to provide the incentives necessary to cause firms to increase their ridership and service levels. Thirdly, an exhibit is presented, based upon Virginia data, which shows the relative real cost to the locality of providing a subsidy under various mechanisms.

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*One of the most recent and poignant examples of the transit subsidy problem in Virginia is exhibited by the front page story in the February 9, 1975, issue of the Charlottesville Daily Progress: Charlottesville's only bus company, Yellow Transit, has requested an additional subsidy of $40,000 just to remain in operation through July 1, 1975. This amount, if granted, would bring the total for 1975 to $85,000, no part of which is used for capital costs.

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SUMMARY AND RECOMMENDATIONS

Summary

In this report the author shows that basically only two economically justifiable arguments can be used in support of subsidies: Arguments based on economic efficiency, specifically that the transit industry tends to be characterized by economies of scale; and arguments based upon the contention that by subsidizing public forms of transportation, significant reductions in such externalities as congestion and pollution can be achieved. The validity of even these arguments depends upon proof that significant economies of scale exist in bus rapid transit and that a mechanism can be devised which will provide the necessary incentives to cause firms to increase their ridership and service levels.

Although it is emphasized that no general statement regarding subsidies to firms can be made until the existence of economies of scale can be substantiated, four criteria for judging the relative merit of various subsidy schemes are suggested in the event that a decision to provide a subsidy has been made:

(1) Choose a mechanism which is effective in achieving social goals. This necessitates that the explicit goals of providing the subsidy be stated prior to the granting of any funds.

(2) All other things being equal, choose a subsidy mechanism which minimizes the cost of distribution and policing (that is, a mechanism which does not require that a substantial amount of resources be spent in distributing the funds and monitoring their use).

(3) Although it is not really a choice criterion, decision makers should take care to identify whether or not they are basing their judgment of the merits of a particular mechanism on some consideration of equity. Equity is not an objective criterion upon which to judge a subsidy mechanism, but if one mechanism is preferred over another solely on the basis of what the choosers consider to be fair, then this fact should be explicitly stated.

(4) Above all, the mechanism chosen should stimulate the firm to operate efficiently, and not be wasteful of resources in any way. Obviously this

criterion is closely tied with the criterion of effectiveness and can be achieved to a certain extent through regulation, but only at the expense of increasing distribution and policing costs.

Based upon these criteria, it can be concluded that subsidies which are tied to some measure of output are preferred over deficit related subsidies because the former can be expected to be more efficacious in achieving increases in service levels and the maintenance of low fares. However, regardless of the specific type of output formula designed, each will have to be scrutinized to ascertain its particular shortcomings and merits. Furthermore, even though there has been widespread use of capital cost subsidies, they do not necessarily lead to the removal of deficits or to increases in output levels; their effect depends upon the particular firm and the city in which it operates. On the other hand, subsidies which are designed to help defray operating costs or variable costs (such as administration and personnel costs) are desirable to the extent that they are positive inducements to increase service levels and innovation.

Recommendations

The following recommendations concerning subsidies to public transit are made to transportation planners.

(1) Subsidies should be made only as a last resort to assure the availability of transportation through an efficient and relatively inexpensive mechanism. This implies that a subsidy should not be provided simply to keep a particular firm in operation if other transit alternatives are available. In short, subsidization for mass transit is in no sense a cure for current urban transportation problems.

(2) No subsidy should be made which is based upon covering deficits or a portion of deficits.

(3) If a decision to subsidize has been made, a realistic estimate should be made of the cost of actually disbursing the funds.

(4) Before subsidies are granted it should be ascertained that either significant scale economies do exist or that a significant reduction in pollution or congestion will result from a subsidy.

Further, it is necessary to establish that no other means is available to meet the transportation need.

(5) Widespread capital grants should not be made without accompanying regulation to ensure efficient usage of funds and guard against insufficient maintenance and early capital retirement.

(6) Regardless of the particular formula chosen, the amount of the subsidy should be structured to the particular characteristics of the firm or firms to be subsidized. (See last section of report: Comparison of Costs of Different Subsidy Formulas.)

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INTRODUCTION

Traditionally, economists have agreed that in the case of public goods government intervention in the market system is desirable. That is, where it is extremely costly to confine the benefits of the good to selected persons and therefore extract the necessary payment from them, the government can supply the good at a price equal to zero. The most often cited case fitting these characteristics is national defense. There are numerous other examples, as well: Maintaining a police force, fire department and other service agencies; cleaning and repairing streets; operating school systems, etc.

In addition to the pure public goods case, there are some other situations in which the market system may not be able to extract from consumers a price high enough to cover costs of production. One of the most widely recognized examples is the public transit industry during the last decade. Ronald J. Fisher of the Urban Mass Transportation Administration has succinctly described this situation. To quote Mr. Fisher,

> It is widely recognized that insufficient funds are being generated by the users of urban transit systems to cover operating expenses and capital improvements. Unless additional outside sources of funding are developed, urban transit systems will gradually disappear. If there is justification for continuing the existence of urban transit systems in American Cities, mechanisms are needed for implementing an operating expense subsidy.(1)

Although the proposal of offering operating subsidies has received relatively little sympathy until recently* it is not

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*The 1974 National Mass Transportation Assistance Act (NMTA) explicitly provides funds for operating subsidies. Of the $11.8 billion provided by the Act, approximately $4 billion can be used for capital or operating programs.

unusual to find that allocations from construction and maintenance funds of state departments of transportation (DOTs) are frequently made in the form of capital grants to public transit firms and/or authorities. The state of Virginia is not atypical in this respect. For example, the legislature for the 1974-1976 biennium has enacted legislation which provides that substantial amounts from the highway trust fund be allocated to urban mass transit to supplement other allocations from the highway budget. These include $15 million to the Northern Virginia Transit Commission (NVTC) as a credit against the locality's obligation for for Metro construction, and $200,000 to NVTC for administrative costs. In addition, $1 million has been provided for capital costs and $70,000 for administrative costs for the Greater Richmond Transit Company. Further, the legislature has earmarked $600,000 for capital costs and $70,000 for administrative expenses to the Tidewater Transportation District Commission. Of the total 1975 highway budget of approximately $334,463,000 that was approved, $6,830,000 was allocated for public transit. Along with an original appropriation of approximately $11.5 million, this brings the total appropriation for mass transit during the period July 1, 1974, to July 1, 1975, up to $18 million.(2)

The growth in allocations from highway construction and maintenance funds in the various DOTs to provide for capital grants to public transit appears to be indicative of a trend which will likely continue. It is to be expected that the operating subsidy will receive increasing attention and application since the passage of the 1974 NMTA. Thus it is appropriate to analyze from both a theoretical and a practical standpoint the specific problems and prospects which subsidies to mass transit will bring about.

PURPOSE

The general purpose of this report is to provide an analysis of the subsidy issues in public transportation. Two related questions are addressed: First, is there an economically sound justification for the provision of subsidies of any kind; and second, how do the various subsidy schemes differ and how do they compare in terms of achieving an overall social goal of ensuring the provision of public transit service? There are several anticipated benefits of this report. First, the report suggests guidelines for planners, well in advance of any actual disbursement of funds, for establishing what is economically justifiable and what is not in terms of operating subsidies and capital grants. Secondly, the study provides the transportation planner with a single reference containing a description and the relative merits of the several

types of subsidy schemes. Finally, the report outlines a set of economic criteria that will enable planners to choose a specific program consistent with the goal of providing efficient and adequate public transit should the legislature decide in favor of a subsidy program.

SCOPE

The first major part of the report consists of a discussion of whether a valid case can be made for subsidy to public transit in general. This part, of course, takes into consideration the question of whether all transit modes fit the qualifications upon which subsidies are determined to be justified. The second major part presents a set of criteria that could be used to analyze the acceptability of various subsidy schemes. The third major portion presents the various schemes available and analyzes each in terms of the criteria set forth in the second part. The fourth and final section consists of a brief summary and presents the researcher's recommendations regarding subsidies in general, their merits, and their disadvantages. The final section also presents estimates of the cost of each type of program based on representative data from transit firms in Virginia.

SUBSIDY AND THE SUPPLY OF PUBLIC TRANSIT: HOW STRONG A CASE?

The Effect of Subsidy on the Level of Supply and Output

A logical first step in determining the extent to which a case can be made for subsidies of any type to public transit is to define exactly what a subsidy is and to show how it alters the equilibrium price and output of the good or service to be subsidized.

As an example, note Figure 1. It represents the market supply and demand for a good called widgets. If S is the supply curve and D the demand curve, then the market price is defined as equal to P^o = \$2.00 and the quantity sold = 12 widgets. If the government deems it desirable to increase the number of widgets being sold to the public because they positively influence people's health, granting a per-unit subsidy to the widget producer could aid in achieving this end. A per-unit subsidy is defined as a fixed amount payable to a producer or consumer for each unit produced or purchased. The per-unit subsidy as shown in Figure 1 equals \$1.00, which means that for each unit of widgets sold the

producer gets $1.00 of added revenue from the government. In effect, this per-unit subsidy shifts the supply curve vertically downward from S to S' because at all levels of output the supplier of widgets is willing to accept a smaller price from the consumer. In other words, a given quantity will be supplied at a price lower than would have been necessary to call forth the same quantity prior to the subsidy. Also from Figure 1, point S, it can easily be seen that after the granting of the subsidy the buyer purchases a greater number of widgets (14) at a lower price ($1.50 instead of $2.00). It is important to notice that the market price of the subsidized good is not reduced by the full amount of the subsidy. Only in very special cases would the price to the consumer fall by the amount of the per unit subsidy.

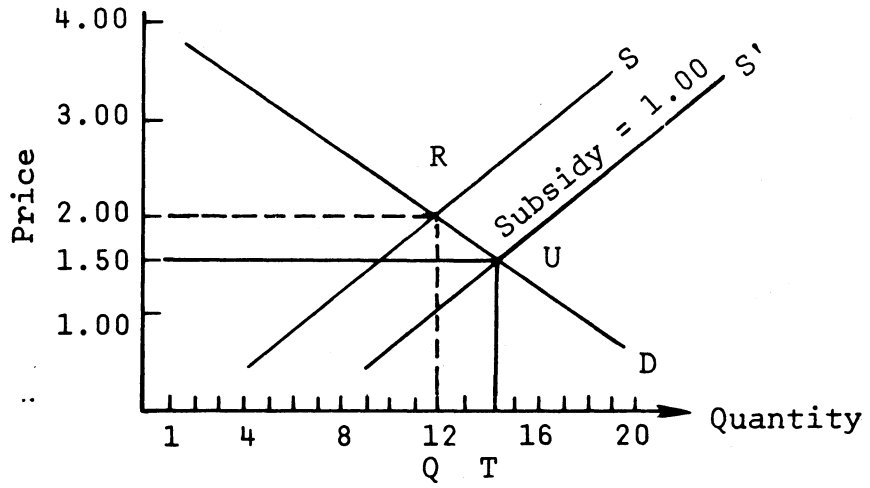

Figure 1. Effect of subsidy on price and quantity.

Why Grant a Subsidy?

The analytical description of how a subsidy alters the market price and output of a good or service is rather straightforward. Nevertheless, one may reasonably question whether there is any justification for subsidies. There are a number of reasons cited for using government money to bolster public transit facilities in financial difficulty. Most, however, tend to be weak arguments based on less than purely economic grounds. One can classify arguments given by subsidy proponents into four major classes: (1) Arguments related to altering the distribution of income; (2) those

based on "infant industry" considerations; (3) arguments based on emotional appeal; and (4) arguments aimed at correcting inefficiencies in the public transit market. These will be discussed in turn.

Arguments Related to Altering the Distribution of Income

Those arguments which can be classified in the first category are likely those which have most often been heard by the public. Frequently, subsidies either to riders or firms are suggested because increasing fares hit hardest the poor and the elderly of inner cities. This alleged inequity is often "remedied" by providing discount rates for riding to worthy groups who have little access to other forms of transportation. According to some authors, a well-defined political consensus has been established on the desirability of such practices.(3) Such an argument raises some serious questions, however. First, who will define what a worthy group is and how will he do so? And secondly, even if it is decided that those below a certain level of income or above a certain age deserve to have money redistributed to them, is it not doubtful that subsidizing their ridership on public transit is the best means of achieving such a redistribution? A stronger case can be made for simply increasing the income of the members of the group and allowing them to decide how they wish to spend the added income. In Canada, for example, where subsidization of urban public transport by municipal government has become a standard practice, empirical estimates of the effect on the distribution of income show that in general income inequality is increased by the subsidies. That is, those in the higher income categories receive most of the benefits of reduced fares.(4)

"Infant Industry" Arguments

Legislators in under developed countries often push for high tariffs to protect their fledgling industries from severe competition from foreign imports. The argument says essentially that if the new industries can be protected long enough to become strong, then the protection can be lifted with no detrimental effects.

Frequently an analogous argument is posited for subsidizing public transit, particularly buses. A proposed Senate Bill (S.870) states:

> ...immediate substantial Federal assistance is needed on an interim basis to enable many mass transportation systems to continue to provide

> vital service during the period required to overhaul and revitalize mass transportation operations and to place them on a sound financial basis.(5)

Although such arguments appear to be acceptable on their surface, inspection shows them to be rather weak. In the case of "infant industries" the supporters of protection can cite examples of the profitable industries they are trying to emulate. In the case of public transit, however, there is little or no evidence to show that unprofitable transit operations, be they bus or rail operations, once subsidized become financially stable. The tendency is for the subsidy to continue indefinitely. In short, such "shot in the arm" arguments are quite lacking in empirical support,(6) and tend to be a stepping stone to long-term financial assistance.

A related argument suggests that the transit industry is simply in a temporary disequilibrium state and therefore has profit potential. If such is the case, one may ask why an opportunistic entrepreneur does not simply take over and consolidate floundering firms; then they could be jointly turned into profit makers.(7)

Arguments Based on Emotional Appeal

The third category of arguments is by far the most difficult for the economic analyst to appraise. Two of these are: Public transit in years past has contributed substantially to America's growth and success and will be even more important in the future, and public transit is the only means of mobility for certain captive riders such as the aged and disabled. Underlying these emotional arguments there may, in fact, be some sound arguments based on economic efficiency. However, as they stand, they are wrought with social and ethical value judgments, which do not lend themselves to an economic assessment of their validity.

Arguments Aimed At Correcting Inefficiencies

Efficiency

The arguments based on efficiency are, in the author's opinion, the only group from which any sound justification for the subsidization of public transit can be drawn. First to clarify this was Harold Hotelling, whose own words are most appropriate:

> When a decision whether or not to construct a railway is left to the profit motive of private investors, the criterion used is that the total revenue, being the sum of the products of the rates (prices) for the various services by the quantities sold, shall exceed the sum of operating costs and carrying charges on the cost of the enterprise. If no one thinks that there will be a positive excess of revenue, the construction will not be undertaken...this rule is, from the standpoint of the general welfare, excessively conservative. A less conservative criterion is that if some distribution of the burden among the population is possible such that everyone concerned is better off than without the new investment, then there is a prima facia case for making the investment.(8) [emphasis added]

Hotelling was speaking about those industries characterized by economies of scale, of which the rail industry was a prime example. (See next paragraph for explanation of economies of scale.) For industries not characterized by economies of scale, economists have long recognized that by setting the price of each unit of output equal to the incremental cost of producing the output each firm will not only maximize profits, but will also produce the level of output consistent with the output demanded by society.(9) In such cases, each firm is said to be operating efficiently.

When an industry is characterized by increasing returns to scale, the cost of each successive unit of output is less than that of the previous unit. Industries which have cost schedules of this nature will not have an efficient level of output if the unit price is set equal to the incremental cost of production. To use rail transit as an example, consider a train hauling ten passengers. Conceivably the cost of operating the train would be split among the ten passengers equally if it were necessary for revenues to cover costs of operation. That is, total costs could be recovered if fares equal average costs. Obviously, if the train had unused capacity, the hauling of ten more passengers would add almost nothing to costs, i.e. the incremental or marginal cost of each additional rider would be very slight. It follows that average costs — total costs divided by the number of riders — would fall.

In such a case where average costs decline, if each passenger is charged a fare equal to marginal cost, the total revenue generated would not cover total costs. The hypothetical cost schedules shown in Table 1 are helpful in illustrating this point.

Table 1

Cost Schedules of Hypothetical Rail Firm

(1) # Passengers	(2) Total Cost	(3) Avg. Cost	(4) Change Total Cost	(5) Marg. Cost
			4 ÷ change in # passengers	
100	2,000	20	1,000	10
200	3,000	15	600	6
300	3,600	12	400	4
400	4,000	10	300	3
500	4,300	8-3/5		

As columns 1, 2 and 4 indicate, total costs do not increase proportionately with ridership. (This phenomenon characterizes mass transit firms because operating costs are relatively minor in comparison to total costs. That is, capital costs make up the bulk of total costs.) As column 5 shows, the incremental or marginal cost of each additional 100 passengers decreases. When 300 passengers are riding, the marginal cost is 6. Setting the fare at 6 will yield 1,800 in total revenue, obviously not enough to cover total costs of 3,600.

Total costs could be covered if fares were set equal to average costs, however less than the socially desired level of output would result. A graphical depiction of the information given in Table 1 is presented in Figure 2 to illuminate this point.

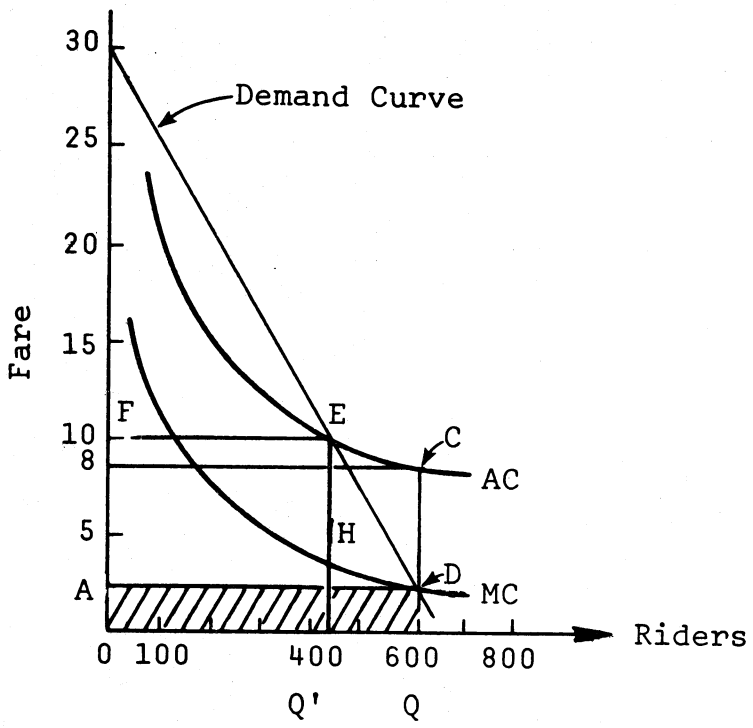

Figure 2. Marginal cost and average cost curves of hypothetical firm.

D represents the demand for public transit service at various fares. AC is the plot of average cost as it varies with ridership and MC is a plot of the marginal cost of adding riders. As noted above, Stigler and Mansfield (f.n. 8), among others, have explained that setting price equal to marginal cost in most markets leads to an optimal allocation of resources and the socially desirable level of output.* In Figure 2, however, if price is set where MC intersects the demand curve, D, then total revenues, OADQ, are less than total costs, OBCQ, and the firm operates in the red. On the other hand, if the firm sets price where average costs can be covered, point E in Figure 2, then the price riders are paying, QE, is greater than the cost, QH, of the resources being used to produce output OQ. This illustration suggests that ridership should be expanded and more resources shifted to the production of public transit services. The only way, however, that more riders can be attracted is to lower fares below price Q'E = 10; but when the fare is lowered below 10, the average cost is no longer covered by the fare paid by each passenger and total revenues fall short of total costs.

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*This assumes no external social costs or benefits.

Thus the transportation planner in a congested urban area is faced with a rather sticky dilemma. He can either allow the transit authority to flounder with high fares, low ridership, and growing deficits that will result in added congestion or he can suggest subsidization from the public sector. If in fact public transit operations are generally characterized by cost configurations like those in Figure 2, by giving a subsidy of p cents equal to the difference between AC and MC (CD in Figure 2) fares can be reduced, ridership increased, and a movement made toward the optimum allocation of travel among various modes. In short, the subsidy serves to shift the cost curves vertically downward as was described in Figure 1.

Based upon this analysis, an obvious question which should be uppermost in the minds of those in the decision making role is the extent to which the transit industry in their state is characterized by increasing returns to scale. In other words, for Virginia, do the cost curves look similar to those in Figure 2? Several authors have offered evidence based on aggregate data that the rail rapid transit industry is characterized by increasing returns.(10) The empirical validity of scale economies in the bus transport industry is not well substantiated, however, Peskin (1973) and Mohring (1972) have offered rather strong cases for the existence of economies of scale.(11) It must be emphasized, however, that empirical verification of the cost curves for Virginia's transit authorities is a desirable undertaking in order that subsequent subsidy decisions can be based on firm economic grounds.

External Effects

Not unjustifiably, it has been argued that increasing the volume of riders on public mass transit modes is beneficial not only to the riders but to society as a whole.(12) That is, there are beneficial effects on individuals other than those who ride public transit. These external effects may take the form of reduced congestion, reduced noise pollution, cleaner air, etc.. All external effects arguments are not suitable as a basis for subsidizing transit however. Among these are arguments such as, "the encouraging of additional riders will increase property values" or "the building of new facilities will create employment." These effects are pecuniary externalities; they alter the distribution of income but don't affect society's net welfare.

The possibility of reducing congestion and pollution or increasing safety by attracting riders away from private autos to mass transit modes is a justifiable basis for subsidies in some sense. However, providing mass transit with an operating subsidy which reduces fares is not necessarily the best way of achieving

this transfer of modes.[13] The extent to which a switch in modes is achieved depends crucially upon the cross price elasticity of demand between transit fares and demand for the auto as a mode of travel. An alternative approach may simply be to properly price the use of autos by taxes or tolls so that the cost of traveling by car includes the cost of pollution, noise, and congestion imposed on society.* In light of these suggestions, it is very important that two estimates be made; one is the degree of change in the modal split that will result from a subsidy, and the other is the change in the external effects that can reasonably be expected due to the estimated change in modes.

Summary: The Case for Subsidy

The several arguments for subsidizing public transit have now been briefly presented and analyzed. The conclusions are, first, that subsidies are warranted only when they promote efficiency in the choice of modes within the transportation sector, or eliminate adverse externalities. Secondly, no general statement regarding subsidies to bus transit can be made without first considering whether or not the operations are in fact characterized by economies of scale. Finally, the cost of administering a subsidy cannot be overlooked in the decision making process. (This point will be discussed fully in the section that follows.)

CRITERIA FOR JUDGING THE RELATIVE MERIT OF ALTERNATIVE SUBSIDY SCHEMES

Capital subsidies to public transit are a reality[14] and funds for operating subsidies have been appropriated at the federal level.[15] So, given that (depending upon the cost curve configuration) an economic justification can be made for subsidization in an amount equal to the difference between average cost and marginal cost, it is pertinent to determine criteria that can be used to judge whether one subsidy scheme is more suitable than another. Four criteria are suggested in this section, some of them more applicable than others.

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*The implementation of such a system of tolls and taxes is currently being tested by the Urban Institute in collaboration with the Federal Department of Transportation.

Consistency With Social Goals

The first and possibly foremost criterion is that subsidy schemes or formulas must be consistent with the social goals for which they are provided. The application of such a criterion implies that the goals which the subsidy is designed to achieve must be specifically decided upon prior to the granting of any funds. This implication is in itself quite advantageous to planners because it eliminates much of the vagueness which so often pervades expenditure decisions.

At least three objectives are easily identified. The one which is most obvious and which is most often cited is that of saving public transit.(16) That is, the objective of providing a subsidy is to ensure that public transit is available as an alternative to the single vehicular mode. A second objective, and one that may be given different degrees of emphasis from locale to locale, is to provide certain groups of people (the elderly, the poor, the handicapped) with a means of transportation within their budgets and their physical abilities. A third objective is to attract increasing numbers of riders from automobiles to public transit in anticipation of reducing severe congestion. This objective is one of particular importance to transportation planners in rapidly growing urban areas. Although other objectives are often suggested, for the most part they are variants of the three just mentioned.

In sum, the "Consistency With Social Goals" criterion has two important implications. First, its use will necessitate an explicit statement of objectives. Secondly, if one of the objectives is to ensure that public transit is available, there should be no concern for saving a particular company; rather the emphasis should be on assuring that some form of viable transit is available.

Minimizing Administration Costs

The cost of administering a subsidy will in most cases vary with the particular subsidy scheme chosen. Because the primary responsibility of a transit firm is to supply a good quality product, care must be taken that an excess of resources is not devoted to qualifying for and obtaining the subsidy. Some subsidy formulas, however, require each firm to develop an extensive data recording system which may effectively destroy a large portion of the subsidy. Based upon this criterion, with all other things being the same, the subsidy scheme which costs the least in terms of actual administration should be chosen.

Equity

As an objective choice criterion equity is extremely difficult to apply because each decision maker has in many respects quite a different idea of what is and is not fair or equitable. While one may prefer that the subsidy be neutral in terms of its effect on the distribution of income, others may make an equally strong case for choosing a subsidy mechanism which increases the real income of the lowest one-third of the income distribution. Still, this researcher is of the opinion that better decisions can be made if considerations of equity are explicitly separated from other more objective ways of judging the relative merits of particular subsidy schemes. It is important that decision makers be cognizant of the fact that by choosing subsidy scheme A as opposed to subsidy scheme B, they are also choosing one income distribution as opposed to another. That is, the type of subsidy scheme chosen will necessarily imply that certain income groups will have a different real income after the subsidy. For example, subsidy scheme A may result in increased ridership (because of reduced fares) by individuals who have an average income of $10,000 and be funded largely by taxes on individuals with smaller average incomes. Subsidy scheme B may make service more available to elderly, low income individuals and be funded by taxes largely from high income families. Obviously, the two schemes involve two different income distributions and, therefore, two different judgments about what is equitable or fair.

Promoting an Efficient Operation

The fact that firms react to the economic incentives they face provides the basis of the fourth criterion suggested for judging the various subsidy schemes. Some schemes will lead firms to operate in undesirable ways. For example, grants for subsidizing capital formation and purchasing factors of production may lead firms to substitute low cost capital for relatively high cost labor; that is, induce them to do little maintenance and upkeep. This reaction on the part of the firm or firms results in a loss to society because subsidy funds are being wasted in the sense that rolling stock is replaced more frequently than depreciation and normal wear would require. On the other hand, subsidies which simply cover deficits offer little or no incentive for management practices which lead to efficiency in allocating resources. Obviously, losses in efficiency are difficult to estimate ex ante, however, some attempt should be made to rank subsidy schemes on the basis of their ability to provide incentives for efficiency. Practically speaking, those schemes which minimize losses in efficiency will likely be most effective in achieving the goals for which the subsidy is provided.

DESCRIPTION AND ANALYSIS OF ALTERNATIVE SUBSIDY FORMULAS

Alternative Subsidy Mechanisms

When considering subsidy schemes it is important to realize that a subsidy mechanism, regardless of its simplicity or complication can be analyzed properly only in the context of the overall goal for which the aid is designed. An attempt will be made in the analysis section of this report to keep this fact clearly in view for the reader.

Although there are numerous formulas that can be used to distribute subsidies, only broad classes and their relative merits will be discussed here. An appropriate way of classifying subsidy mechanisms is by the basis upon which the subsidy is granted. In this section, subsidy mechanisms are separated into the following classifications: (1) Deficit Related, (2) Cost or Input Related, (3) Output Related, and (4) Potential Ridership Formulas.

Deficit Related Subsidies

The simplest form of subsidies to public transit is one in which total deficits are covered. Under such an arrangement the transit firm receives a subsidy equal to the difference between its total cost and total revenue. A variant of this formula is to cover a percentage of the deficit. Deficit related subsidies are unequivocally the weakest in terms of meeting the criteria established above.

Consistency With Social Goals

When there is an open-ended agreement to simply cover deficits, firms can continue their current practices ad infinitum. If the legislature's only goal is to propagate existing service levels, this formula can achieve that end. However, assuming that it is desirable to provide incentives to increase output and the quality of service, a subsidy which simply covers deficits will not be effective. It has been suggested that such a subsidy would not penalize those firms who attempt risky innovations.(20) Although this may be true, those firms attempting innovations may in fact cease these attempts upon receiving a deficit based subsidy;* and firms already in a deficit position and not attempting innovations would have only a nuance of incentive to initiate them.

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*The premise is that if innovations were being made, they were in an attempt to compete for or attract a larger market to offset losses. If, however, losses are being covered by subsidy, presumably there is little incentive to try to overcome losses from within.

Costs of Administration and Efficiency

Because little additional record keeping is necessary,the costs of administering a deficit based subsidy program are relatively small. However, the grantors would have little, if any, control on the management of recipient firms. Hence, there is little incentive to operate firms efficiently. Even firms operating efficiently at a loss prior to the granting of the subsidy may cease their efficient practices when losses are covered from public funds. It would not be unusual under a deficit scheme to find firms expending resources to get the subsidy. In short, they would become loss maximizers rather than profit maximizers.

Equity

As for equity, one is left rather cold. Those firms receiving a subsidy will certainly be better off. However, there is no assurance that riders will get any service increase from their dollar.

Cost or Input Related Subsidies

Subsidies that are based either upon covering capital costs or the purchase of other fixed cost inputs have been in widespread use for sometime. Because many public transit modes are characterized by economies of scale, that is, they require substantial outlays of capital initially, these types of fixed cost subsidies have been rather attractive to legislators in their attempt to help solve the public transit problem.

Consistency with Social Goals

Covering such fixed costs as buses and garages will not assure, however, that firms in deficit positions will break even and continue to operate in the long run. Whether they do or not depends upon their individual capital structure and the cities in which they operate. In short, capital grants do not guarantee that fares will remain stable and that quality service will be forthcoming. The important question the planner must face is whether the capital grant will actually lead to the purchase of more productive capital and rolling stock or just enter the revenue side of the ledger.

Costs of Administration and Efficiency

If capital based subsidies were to result in innovations in the product and in marketing which in turn led to increased ridership, society as a whole would gain.* However, capital grants to individual firms in and of themselves appear no more likely to possess innovative inducements than do subsidies which are based upon the firm's deficit position. This statement should be qualified, however. If the granting agency wishes to provide inducements to innovations and efficiency in the provision of quality service, these can be provided through government control, but only by increasing administrative costs substantially. This in fact is what a transit authority does — provides the desirable inducements to innovation and efficiency.

Equity

Because most capital based subsidies do not take account of the source of a firm's financing, a substantial portion of funds will be funneled to firms that have financed their capital from sources other than their own equity or that already are in a profitable position. Even casual observation suggests that bringing about such windfall gains to subsidy recipients is undesirable on the basis of what is equitable to the firms. The effect that a capital subsidy will have on the distribution of income of the riders is for the most part unpredictable because, as was noted above, the fare structure may or may not be altered as a result of the subsidy.

Although the administrative costs will be greater, much of the discussion concerning capital based subsidies applies to operating cost subsidies as well. Both tend to lead to windfall profits and neither assures the achievement of the goals of aid to mass transit. From the standpoint of being a positive inducement to innovation, subsidizing operations expenses are preferable to capital subsidies to the extent that innovations, particularly in the bus — only mode, and increases in service levels are achieved through changes in variable costs (number of stops made, headways, personnel) rather than additions to the capital and rolling stock.(21)

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*Through a reduction in externalities.

Output Related Subsidies

Output related subsidies are tied in some sense to the product of public transit firms. In other words, the amount of subsidy granted depends upon the quantity of service the firm provides and only indirectly relates to its profit or loss situation. It is appropriate to consider several output related subsidies rather closely because the relative merits and disadvantages of each are quite different.

One basic type of output related subsidy is the Revenue Passenger Formula. This type of subsidy formula either allocates money directly to paying passengers in the form of tokens, stamps or other means by which fares are reduced, or allocates money directly to transit firms on the basis of the number of passengers carried. This was the type of formula implied by the legislation before the 92nd Congress proposing a federal subsidy to mass transportation.[18] Algebraically this formula may be written as:

$$X_F = S_P Q_F$$

where

$$S_P = \frac{X_T}{EQ_F}$$

This means that the subsidy to each firm, X_F, equals a subsidy rate per passenger, S_P, times the number of revenue passengers carried by the firm, Q_F. The subsidy rate, S_P, is a uniform rate calculated by dividing the total dollar amount allocated for subsidy X_T by the total number of revenue passengers carried by all firms, EQ_F.*

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*Variants of this formula could be developed either by restricting the subsidy to certain firms or by altering the rate on the basis of some measure of need. These changes would not, however, materially alter the analysis which follows.

A second category of output related subsidy, the Vehicle Miles Formula, allocates funds to transit firms based upon the number of miles traveled. This differs from the Revenue Passenger Formula only in that the base on which the subsidy is allocated is vehicle miles rather than paying passengers. Placed in algebraic form, the formula is

$$X_F = S_M M_F.$$

where

X_F = total subsidy

S_M = subsidy per mile

M_F = miles logged

That is, the total subsidy to each firm is determined by a uniform subsidy rate per vehicle mile times the number of vehicle miles logged by the firm. The rate, S_M, is calculated by dividing the total subsidy funds available by the number of vehicles miles traveled by all firms.

These two output related subsidies can be analyzed in terms of the criteria suggested previously.

Consistency with Social Goals and Efficiency

In general, output related subsidies have an advantage in helping to achieve the goals of increasing service levels and reducing fares. That is, analytically such subsidy mechanisms approximately institute the chain of events depicted in Figure 1 because the size of the subsidy granted is linked directly with the firm's level of output. The Revenue Passenger Formula specifically could be expected to provide incentives necessary to increase service levels and reduce fares because a greater subsidy can be obtained only through an increase in the number of paying passengers. The Revenue Passenger Formula is not free from criticism, however. The extent to which fares are lowered will depend upon the degree to which the granting agency monitors the operating ratio $\left(\frac{\text{Total Costs}}{\text{Total Revenue}}\right)$ of the firm. Without monitoring, fares will not be reduced substantially nor will the benefit of the subsidy be passed on to the riders. Instead, the subsidy will simply be added to revenue with no reduction in fares.

Costs of Administration and Equity

The use of a Revenue Passenger Formula would necessarily imply that a substantial amount of the money intended for aid would be eaten by the exorbitant costs of distributing the funds. The primary cause of the excessive costs is the fact that no uniform method of record keeping is currently followed by firms, and consequently it would be almost impossible to obtain the data necessary to estimate the rate of subsidy per revenue passenger and in turn the total subsidy per firm. If, rather than giving the subsidy to the firm on the basis of the number of passengers, the passengers themselves are given tokens which reduce their fare, additional administrative problems arise. The printing of the tokens involves costs, but more importantly, two questions of equity must be faced: How is the grantor to decide who is eligible? and, Do all eligible recipients receive the same amount of subsidy? A final issue that cannot be settled easily by objective criteria is that this type of mechanism will favor firms with certain market characteristics. Those firms with short hauls for a given number of passengers or those firms with low fares at the time the subsidy is granted will be able to increase their ridership relatively more easily than firms that have long haul markets or relatively high fares. Thus, the former firms will be in a position to receive larger amounts of subsidy with relatively less effort.

Much of the analysis that applies to the Revenue Passenger formula applies to the Vehicle Miles Formula, a second type of output related subsidy. Where relatively inexpensive monitoring can be devised, the advantages of this mechanism can be retained while guaranteeing that (1) ineligible miles are not logged, and (2) operating ratios $\left(\frac{TC}{TR}\right)$ are established which necessarily pass the subsidy on to users in the form of either reduced fares, increased service levels, or a combination of the two. Because output is the basis of the subsidy, the incentives for innovation and quality increases are strong. This fact, in addition to the relatively small information, data, and administrative problems involved, establishes the Vehicle Miles Formula as being among the better alternative subsidy mechanisms.

Potential Riders Formula

Although formulas of the potential riders type have not received significant attention, some people have suggested or implied that they might be feasible.(9) The foundation of such suggestions is that even though an individual does not ride frequently, he may receive some positive benefit from the availability

of public transit. The algebraic formula is similar to that for the Revenue Passenger Formula:

$$X_F = S_N^{**} N_F$$

where

X_F = subsidy to the firm

S_N^* = the rate of subsidy per potential

N_F^* = the number of potential riders.

In this case, the subsidy to the firm, X_F, is directly proportional to the number of potential riders, N_F^*, along the firm's route.

A variant of this scheme is simply to grant a subsidy on the basis of the population in each locality. Such a mechanism is the same as revenue sharing, except that the money must necessarily be used for the explicit purpose to aid public transit.

Although formulas in this category are conceptually the best in terms of meeting the criterion of goal achievement, they are by far the most intricate that can be devised. Each of the categories previously discussed is based, for all practical purposes, upon the existing situations as regards capital outlay, number of passengers, and number of miles logged. A Potential Riders Formula, on the other hand, is based upon the potential market for transit; that is, it takes account of those who would use the service infrequently but who would value its potential service. If the exorbitant costs of estimating the basis of the subsidy could be overcome, one could expect that the implementation of such a mechanism would result in more route miles traveled in densely populated areas and an increase in the quality of service offered.

COMPARISON OF COSTS OF DIFFERENT SUBSIDY FORMULAS: SELECTED VIRGINIA CITIES

One of the recommendations presented at the beginning of this report states:

> Regardless of the particular formula chosen, the amount of the subsidy should be structured to the particular characteristics of the firm or firms to be subsidized.

This recommendation may appear to be quite obvious once it has been stated. However, its ramifications become clear only when one compares the cost of subsidizing a particular bus company by several different mechanisms: Table 2 clearly shows that the profit or loss position of a firm varies tremendously under different subsidy schemes. Furthermore, for a particular subsidy mechanism, the data show that all firms will not be affected in the same way. An examination of individual cells from Table 2 will clarify these points.

Table 2 shows the comparative costs of providing subsidies to several selected transit systems operating in Virginia's larger cities.* The estimates are based upon data for fiscal year 1973.** The reader is cautioned not to conclude that the data are representative of all cities within the state; the intent of the author is to show how differently a particular subsidy affects each firm. (Widespread data collection and analysis were not within the purview or budget of this study.)

Referring to column one, the subsidy is set equal to total deficits. Firm A receives $389,336 under this scheme, there are no windfall profits, and the deficit is completely removed. Firms B and C receive no subsidy because they are earning a small profit. As note (b) indicates, however, the profit may be too small to meet capital expansion costs. Such a scheme is not well suited to providing the incentive or the revenue for expansion of service levels.

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*Identities have been kept confidential.

**Sources: American Transit Association, 1973 Operating Report; Northern Virginia Transportation Commission, Express Bus Demonstration Project, Financial Summary.

Table 2

Comparison of Costs of Different Subsidy Mechanisms — 1973 Data for Systems Three Urban Areas: Pop. 400,000 or Greater and One Area Less Than 50,000

(Figures in Dollars)

		FORMULA							
		1	2	3	4	5	6	7	8
Firm	Result	Subsidy = Total Deficit	Subsidy = 5% Total Cost	Subsidy = 5% Maintenance Operations, Administrative Cost	Subsidy = Total Maintenance Garage and Equipment Cost	Subsidy = Total Fixed Cost	Subsidy = Depreciation Charges	Subsidy = $.05 per Revenue Passenger	Subsidy = $.05 per Vehicle Mile
A	Total Subsidy	389,336	258,934	225,000	55,912	500,000	132,166	878,255 (d)	261,367 (e)
	% Deficit Reduction	100	66	58	15	129	34	226	68
	Windfall Profit	0	0	0	0	110,664	0	599,983	0
B	(a)Total Subsidy	(b)	194,389	N.A.	N.A.	8,357	167,141	724,004 (d)	190,914 (e)
	Windfall Profit		194,389			8,357	167,141	724,004	190,914
C	Total Subsidy	(b)	123,503	(c) 118,000	(c) 100,000	10,000	N.A.	178,388 (d)	149,884 (e)
	Windfall Profit		123,503	118,000	100,000	10,000	-	178,388	149,884
D	Total Subsidy	62,639	11,868	10,000	N.A.	N.A.	N.A.	35,320	15,000
	% Reduction in Deficit (pop. 50,000)	100	19	16	-	-	-	57	24

(a) Although a firm may be breaking even on the basis of operating costs, it may not have the funds to purchase necessary capital equipment. An interesting point to note is that published data may not indicate that profits are insufficient to finance needed expansion of service.

(b) Profits are positive based on operating cost and revenue, but less than $30,000. ($30,000 would not purchase one bus.)

(c) Estimated conservatively.

(d) The subsidy is an underestimate because it will affect miles traveled.

(e) The subsidy is an underestimate because it will affect number of passengers carried.

N.A. — Data not available.

Subsidies based on a percentage of total cost (column 2) lead to windfall profits for firms B and C, but reduce only a portion of the deficit for firms A and D.

Column 5 shows that subsidies based on fixed costs result in windfall profits for all firms for which data are available; obviously, the larger the fixed costs, the greater the effect on profits. Furthermore, the ability of such a mechanism to provide incentives to increase service levels is absent.

Column 7 is quite interesting. Firms in the large urban areas (A, B, and C) receive rather large profits because they are already carrying large numbers of passengers. The small firm, D, still doesn't break even under this scheme, even though it faces an incentive to increase ridership.

In addition to the general recommendation stated above, two other implications are apparent from the data presented in Table 2. First, no general statement can be made regarding what kind of subsidy mechanism requires the largest outlay of funds. Secondly, regardless of the scheme proposed, the effect on all firms will apparently not follow a general pattern; whereas one may receive huge profits, another may not break even after the subsidy.

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FOOTNOTES

1. "Issues in Public Transportation." Special Report No. 144, Transportation Research Board, 1970, p. 30.

2. Virginia Highway Bulletin, March 1974, June 1974.

3. Meyer, J. R.; Kain, J. F.; Wohl, M., The Urban Transportation Problem, Harvard University Press, 1966. p. 345.

4. Frankena, Mark, "Income Distributional Effects of Urban Transit Subsidies," Journal of Transport Economics and Policy. Vo. 7, #3, 1973. pp. 215-230.

5. U. S. Congress, Senate Ninety-Second Congress, First Session, February 17, 1971, Bill #S.870, Section 2, Paragraph 7.

6. Peskin, Henry M., An Analysis of Urban Mass Transit Subsidies, Institute for Defense Analysis. January 1973. p. 12.

7. Ibid., p. S-4.

8. Hotelling, Harold, "The General Welfare in Relation to the Problems of Taxation and of Railway Rates and Utility Rates." Econometrica, Vol. 6, #3, July 1938. p. 267.

9. Two excellent discussions are found in George Stigler, The Theory of Price, MacMillan and Company 1966, pp. 154-155; and in Edwin Mansfield, Microeconomics, Theory and Applications, W. W. Norton and Co., 1970. pp. 412-440.

10. See Roger Sherman, "Club Subscriptions for Public Transport Passengers," Journal of Transport Economics and Policy, Vol. 1, #3. 1967; and "Congestion Interdependence and Urban Transport Fares," Econometrica, Vol. 39, No. 3, (May 1971).

11. Sherman, 1967. Also see Peskin, p. 7., and Herbert Mohring, "The Benefits and Costs of Subsidizing Increasing Returns Activities." Mimeograph 1973.

12. For example, see the following: H. Mohring, American Economic Review, Sept. 1972; Robert Strotz, "Principles of Urban Transportation Pricing," Highway Research Record #37; David Renshaw, "A Justification For Mass Transit Operating Subsidies," Traffic Quarterly, April 1974; A. A. Walters, "Subsidies for Transport", Lloyds Bank Review, January 1967 #83.

13. Peskin., p. 9; and Elbert Segelherst and Larry Kirkus, "Parking Bias in Transit Choice," Journal of Transport Economics and Policy, January 1973, pp. 58-70.

14. See footnote 2.

15. See footnote 1.

16. Alternate Formulas for a Federal Operating Subsidy Program for Transit, Institute for Defense Analysis, 1971. Also see U. S. Dept. of Transportation publication, "The Feasibility of Federal Assistance for Urban Mass Transportation Operating Costs." November 1971.

17. IDA 1971., p. 5.

18. "Collective Consumption Services of Individual Consumption Goods," Quarterly Journal of Economics, August 1964, Vol. 78, pp. 471-77. Also see Sherman, f.n. #10.

19. Highway Research Record #144 Special Report, David R. Miller, "Financing Urban Transportation," p. 56.

20. Ibid., p. 59.

21. Idem.