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# Contents

# Federal Operating Assistance for Urban Mass Transit: Assessing a Decade of Experience

DON H. PICKRELL

ABSTRACT

Reviewed are developments in the U.S. urban transit industry during the period of federal government operating assistance (1975 to 1984). The financial and operating performance of the nation's transit industry during this period is compared with that during the prior decade (1965 to 1974), when only local and a few state governments provided operating assistance. In addition, estimates are reported of how the $7.6 billion in federal operating assistance disbursed during this period has been utilized by U.S. transit operators. Case studies of transit operators serving 13 urban areas in the United States are also used to explore variation in transit system operating and financial performance during the period of the federal assistance program. Drawing on the findings from these analyses, the paper concludes with an evaluation of the program's continued desirability as a major element of federal urban transportation policy, and two specific proposals for its reform are introduced.

For more than two decades, local government agencies across the United States have offered direct financial assistance to transit operators serving their citizens, and some have offered less visible subsidies for considerably longer. Most states also assist public transit operators indirectly (by exempting them from certain taxes and fees), and several adopted direct subsidy programs beginning as early as 1970. Between 1965--when total fare revenues collected by all U.S. urban transit operators first failed to cover their aggregate operating expenses--and 1975, state and local governments throughout the nation provided nearly $3 billion to underwrite transit operators' escalating deficits (1). The rapid growth of government assistance during this period was accompanied by widespread takeover of transit system assets and operations by local government agencies; thus, by the time the federal government first offered operating assistance in 1975, cities and public authorities already owned and operated 85 percent of all urban transit vehicles and service in the United States, and carried 90 percent of the nations's transit passengers (2).

Compared with local and state government involvement, the federal role in transit operating assistance developed more recently, and has always been more controversial. Many members of Congress originally advocated federal operating assistance as an emergency measure that was necessary to support transit operators temporarily, while they invested in major capital improvements (which were already eligible for federal funding) designed to reduce operating costs and bring increasing deficits under control. [See, for example, Senator Williams' statement reported by UMTA (3,p.II-12).] Widespread public reaction to the 1973 Organization of Petroleum Exporting Countries (OPEC) oil embargo swelled their ranks with new advocates of long-term federal involvement, who asserted that federal subsidies to finance additional transit service and lower fares would reduce energy consumption in urban transportation by attracting new transit riders from those currently commuting by automobiles. Unfortunately, this was based on a misleadingly simple comparison of energy consumption rates for singly occupied automobiles and heavily loaded transit vehicles in line-haul service, which dramatically overstated potential energy savings from increased use of transit under more realistic urban travel conditions (4). There was also little evidence that local and state subsidies had stemmed the shift to automobile travel in the nation's urban areas.

Another rationale for federal involvement was the widespread belief that transit service could not be reduced in proportion to declining ridership so that deficits would inevitably increase in the absence of government subsidies to stabilize fares. Still another rationale was the widely assumed importance of transit service in maintaining the vitality of the nation's downtown areas. (See, for example, Senator Javitts statement in 1974 U.S. Congress joint conference committee hearings, p.2.) There is an implicit connotation that transit is an industry characterized by substantial fixed costs, in which declining levels of ridership inevitably produce increasing deficits. Nevertheless, the number of nationwide vehicle-miles of transit service was reduced nearly 40 percent between 1950 and 1970 (5, p.58, Table 13). For a typical assertion of the importance of transit service to urban areas, see the statement by Representative Rostenkowski (6, p.32787). Unfortunately, this view failed to recognize that the decline of U.S. central cities was fostered by many of the same forces that produced declining transit ridership, principally rising personal incomes and the relocation of employment from central city to suburban areas as production technologies and the composition of the nation's economic output changed.

Despite their generally undocumented empirical validity, these arguments proved to be pivotal appeals: Congress authorized operating assistance under the UMTA Section 5 program beginning in 1975, citing "...the need to provide public subsidies to cover operating deficits in order to preserve adequate transit service at reasonable fares" (7,p.448).

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Assistance payments increased rapidly under the new program, but within 2 years both Congressional advocates and recipients of federal assistance were already decrying its funding level as "...insufficient to permit responsible federal participation" (8,p.15). Assistance payments had already reached nearly $600 million in 1977, but their efforts raised the level of subsidies to nearly $1.1 billion by 1980. Under intense pressure from the new administration, Section 5 grants were reduced to about $900 million by 1983; beginning the next year, operating assistance was combined with formula capital grants under the newly created UMTA Section 9 program, with operating subsidies representing about $860 million of the $2.4 billion in total assistance distributed during the first year of the new program (5,9-13).

Thus, as reported in Table 1, cumulative federal operating assistance payments through 1984 totaled more than $7.5 billion, equivalent to about $9.7 billion in 1984 dollars after adjusting to reflect the greater purchasing power of earlier years' payments.

**TABLE 1 Government Operating Assistance Payments to U.S. Urban Transit Systems (1965-1984)** *(1,5,9)*

| | State and Local Governments | | Federal Government | |
|---|---|---|---|---|
| Year | Actual Dollars (000,000) | 1984 Dollars (000,000) | Actual Dollars (000,000) | 1984 Dollars (000,000) |
| 1965 | 9.6 | 29.0 | - | - |
| 1966 | 35.2 | 103.1 | - | - |
| 1967 | 63.2 | 179.6 | - | - |
| 1968 | 152.0 | 413.9 | - | - |
| 1969 | 208.0 | 538.0 | - | - |
| 1970 | 231.0 | 567.0 | - | - |
| 1971 | 310.0 | 724.4 | - | - |
| 1972 | 333.8 | 748.9 | - | - |
| 1973 | 536.8 | 1,139.3 | - | - |
| 1974 | 1,048.6 | 2,043.8 | - | - |
| 1975 | 1,146.6 | 2,046.4 | 301.8 | 538.6 |
| 1976 | 1,299.5 | 2,203.6 | 422.9 | 717.1 |
| 1977 | 1,393.1 | 2,232.4 | 584.5 | 936.6 |
| 1978 | 1,610.9 | 2,402.9 | 689.5 | 1,028.5 |
| 1979 | 2,178.2 | 2,990.5 | 855.8 | 1,175.0 |
| 1980 | 2,651.7 | 3,334.6 | 1,064.6 | 1,339.0 |
| 1981 | 2,953.8 | 3,387.9 | 999.1 | 1,145.9 |
| 1982 | 3,526.8 | 3,814.9 | 922.9 | 998.3 |
| 1983 | 4,545.6 | 4,736.5 | 887.2 | 924.5 |
| 1984 | 4,895.2 | 4,895.2 | 860.1 | 860.1 |
| Cumulative totals | | | | |
| 1965-1984 | 29,129.6 | 38,531.9 | 7,588.4 | 9,663.6 |
| 1975-1984 | 26,201.4 | 32,044.9 | 7,588.4 | 9,663.6 |

It is difficult to establish whether escalating federal involvement displaced assistance that might otherwise have been provided by state or local governments during this period because the subsidy levels they would have offered in the absence of federal intervention cannot be reliably estimated. After adjusting for inflation, combined state and local operating assistance increased by 260 percent between 1970 and 1975, almost exactly twice the percentage growth in state and local assistance that occurred during the period of increased federal subsidies (1975 to 1984). However, this comparison does not necessarily suggest that federal participation displaced state and local subsidy effort because the dollar increase in inflation-adjusted state and local government operating assistance during the years coinciding with the UMTA Section 5 program (almost $2.7 billion when measured in 1984 dollars) was considerably larger than its growth from 1970 to 1975 (about $1.5 billion in 1984 dollars).

The data in Table 1 indicate that combined state and local operating assistance continued to increase rapidly during the period of increasing federal involvement--amounting to more than $26 billion since 1975, more than three times the federal contribution--so there is no immediate suggestion that federal participation displaced assistance by lower levels of government. Nevertheless, federal assistance has been substantial, and the debate over its future should include an assessment of how it has affected transit operators, as well as how effectively the program has accomplished its original objectives.

## TRANSIT INDUSTRY PERFORMANCE BEFORE AND DURING FEDERAL ASSISTANCE

Table 2 give a comparison of changes in several important measures of transit industry performance for two recent periods: (a) the years from 1965, when total fare revenues first failed to cover its aggregate operating expenses, to 1974, the year before federal assistance began; and (b) 1975 to 1984, the period of federal participation. Changes in performance during the latter period are subdivided into those occurring while federal operating assistance under the UMTA Section 5 program was increasing (1975 to 1980), and the subsequent period (1980 to 1984) of decreasing federal support.

Between 1965 and 1974, local government agencies in the nation's cities were the primary source of transit operating assistance (many of them actually took over ownership and operation of urban transit companies during this time); although several states began direct transit subsidy programs during this period, most financial assistance was provided at the local level. Between 1975 and 1980, subsidy payments by all levels of government increased extremely rapidly, but after 1980 assistance by state and local governments continued to increase rapidly while federal subsidies declined.

As indicated by the data in Table 2, changes in many measures of transit industry performance during these two periods were closely comparable, including changes in two basic measures affecting transit labor costs: compensation and service produced per worker. Annual compensation per employee (which consists of wages plus the estimated value of employer-provided fringe benefits) increased 93 percent between 1965 and 1974, and by another 104 percent during the federal assistance period, as the data in the table indicate.

However, these increases are very different when expressed in constant dollars because of the major inflationary shock dealt the U.S. economy by the OPEC oil price increase during the 1979-to-1980 period. Real compensation levels received by transit workers even decreased from 1975 to 1980, although this occurred throughout the U.S. economy, and their rapid growth resumed during the 1980-to-1984 period. Clearly, the pattern of generous nominal wage and fringe benefit increases established during the era of predominantly local subsidy of the nation's transit industry continued throughout the era of federal participation, as did the industry's historical decline in labor productivity. The major difference between the two periods appears to be that the continuing gains in transit workers' compensation were temporarily offset by the rapid inflation that prevailed during the 1978-to-1980 period.

The data in Table 2 also indicate that the percent increases in actual expenses per vehicle-mile of transit service operated were almost identical for the periods 1965 to 1974 and 1975 to 1984. Again, rapid price inflation during the latter period meant

**TABLE 2 Transit Industry Performance Under Changing Mixes of Operating Assistance from Local, State, and Federal Government**

| | Percent Change During Periods: | | | |
|---|---|---|---|---|
| Performance Measure | 1965-1974 | 1975-1984 | 1975-1980 | 1980-1984 |
| Compensation per employee | | | | |
| Actual dollars | 93 | 104 | 31 | 56 |
| Adjusted for inflation | 54 | 14 | -8 | 24 |
| Service produced per employee | -10 | -7 | -11 | 5 |
| Expense per vehicle-mile | | | | |
| Actual dollars | 135 | 132 | 58 | 47 |
| Adjusted for inflation | 87 | 30 | 11 | 17 |
| Vehicle-miles of service | -5 | 8 | 5 | 3 |
| Passengers carried per vehicle-mile of service | -21 | 8 | 9 | -1 |
| Expense per passenger | | | | |
| Actual dollars | 171 | 115 | 46 | 48 |
| Adjusted for inflation | 73 | 20 | 3 | 17 |
| Average fare paid | | | | |
| Actual dollars | 51 | 55 | 20 | 29 |
| Adjusted for inflation | 20 | -13 | -15 | 3 |

that the real increase in unit operating costs during the federal subsidy era was only about one-third as large as that experienced during the previous decade; however, this difference is also largely attributable to the wave of inflation caused by the 1979-1980 oil price shock. The increase in petroleum prices increased transit operating expenses as well, but it was responsible for only about one-tenth of the 132 percent increase in expenses per vehicle-mile of service between 1975 and 1984 that was reported in Table 2. Further, the data in the table suggest that with the return to more modest inflation rates during the period of declining federal assistance (1980 to 1984), real expenses per vehicle-mile actually increased considerably faster than during the previous years when federal operating subsidies increased rapidly.

The data in Table 2 indicate that the number of passengers carried per vehicle-mile of transit service declined sharply during the years preceding federal operating subsidies, but actually increased somewhat during the years when federal subsidies increased rapidly. Because the historical decline in utilization was temporarily reversed, operating expenses per passenger carried by the nation's transit systems increased much less during the period of federal assistance than during the previous decade, particularly when measured in real terms for the 1975-to-1980 period of rapid inflation. Again, however, the more recent period of declining federal assistance indicates a return to increasing real operating expenses per passenger, as rapid growth in vehicle operating costs resumed and the 1975-to-1980 improvement in transit utilization proved to be short-lived.

Finally, the data in Table 2 indicate that aggregate transit service to the nation's cities declined slowly during the decade of local takeover and subsidy of the nation's transit industry, but that service increased modestly during the period of federal involvement. The pattern of changes in fare levels throughout the period covered by the table suggests that some of the rapid increase in assistance levels was used to avoid raising fares to match the rapid pace of growth in operating expenses.

Much of the temporary improvement in transit utilization during the 1975-to-1980 period probably represents travelers' response to the sharp decline in inflation-adjusted fares (and the parallel rise in gasoline prices), just as the 1965-to-1974 and 1980-to-1984 decreases in utilization no doubt occurred partly because even the extensive substitution of subsidies for farebox financing of operating costs was insufficient to prevent some increase in real fare levels. Thus, although federal subsidies had little visible effect on the transit industry's operating cost performance, the increasing federal assistance levels of the 1975-to-1980 period--in combination with similarly rapid growth in state and local operating subsidies--did temporarily reverse the historical trends of declining service, higher real fares, and declining transit ridership; however, these developments proved both costly and short-lived.

## WHAT HAS FEDERAL OPERATING ASSISTANCE ACCOMPLISHED?

Although there appears to be little evidence that federal operating assistance aggravated the historical declines in transit operating and financial performance, their persistence throughout the period of federal involvement clearly compromised its effectiveness in promoting its advocates' original goals of expanding transit service, reducing fares, and increasing ridership. (Again, it is virtually impossible to distinguish how federal subsidies have been spent from the ways in which other government assistance has been used, and the following analysis does not attempt to identify separate effects of assistance received from different levels of government.)

Most important, rising prices for labor and fuel--the primary inputs used to provide transit service--produced rapid escalation in expenses for providing the same level of transit service that was operated before the federal program began. Expenses for labor and fuel together accounted for 84 percent of the operating expenses incurred by the U.S. transit industry during 1983 (13, p.2-4, Table 2.07). These higher expenses absorbed much of the expansion in transit operators' budgets that was made possible by federal assistance payments, leaving surprisingly little of their growing total available to finance new service or reduce fares. In addition, the types of new service and the specific fare reductions that were implemented by using the remaining assistance produced disappointingly small gains in transit ridership in many urban areas.

Table 3 gives specific estimates of how operating assistance payments by all levels of government during the period of federal involvement were utilized by the nation's urban transit industry. These estimates were constructed by allocating the increased expenditures by all U.S. transit operators between 1975 and 1984 that were financed by growing government assistance among three categories: (a) increased

**TABLE 3 Sources and Uses of Increased Government Operating Assistance Payments During the Period of Federal Participation (1975-1984)**

| | Cumulative Total, 1975-1984 (billions of 1984 dollars) | Percent of 1975-1984 Cumulative Total |
|---|---|---|
| Sources of increased operating assistance[a] | | |
| Federal assistance | 9.7 | 46 |
| New state and local assistance | 11.6 | 54 |
| Total sources | 21.3 | 100 |
| Uses of increased operating assistance | | |
| Higher costs for existing service: | | |
| Labor expenses | 6.6 | 31 |
| Energy costs | 1.5 | 7 |
| Other expenses | 0.9 | 4 |
| Total | 9.0 | 42 |
| Expenses for new service | 5.5 | 26 |
| Replace lost fare revenue[b] | 5.1 | 24 |
| Remaining for future expenses | 1.7 | 8 |
| Total, all uses | 21.3 | 100 |
| Increase in ridership (billions of trips) | 4.9 | 9 |

[a]Cumulative increase in yearly operating assistance payments above their level in 1974, the year before federal assistance began.

[b]Net of fare revenue contributed by new riders.

costs for operating the level of service that existed before the federal assistance program; (b) expenses for operating new service added during the period of federal involvement; and (c) outlays necessary to compensate for reduced farebox coverage of operating expenses. For a detailed description of the methods used to construct these estimates, see Pickrell (16, pp.282-285). Increased costs for operating the original service level were further apportioned among additional expenses for labor, energy, and miscellaneous other inputs.

The outlays necessary to compensate for reduced farebox effort are equal to the decline in revenue from continuing riders when fares were reduced, less any new revenue generated by ridership increases that occurred in response to such fare cuts. The revenue loss stemming from ridership declines that occurred in response to changes in market demand for transit service during this period was also included in this category of increased outlays, although the amount was small. Finally, any new government assistance during this period that was not matched by increased expenditures for one of these purposes (or required to meet previous years' unfunded expenses) was classified as remaining available for future expenses.

The data in Table 3 indicate that since 1975, 46 percent of the new transit assistance has been contributed by the federal program, with the remaining 54 percent representing payments by local and state agencies above the combined level they provided before the federal program began. Of this total, 42 percent--or about $9 billion in 1984 dollars--was used to meet higher costs for providing the same level of service that was operated before the program began. In turn, nearly three-quarters of this amount ($6.6 billion) was used to meet increased labor expenses for supplying transit service. A relatively small proportion of the increase in government assistance (7 percent, or about $1.5 billion) was necessary to compensate for higher energy costs, despite the common assertion that rising energy prices were a major source of increasing transit expenses during this period; higher payments for maintenance supplies, insurance, and various other inputs were responsible for the remaining increase (less than $1 billion) in expenses.

Because these escalating costs absorbed so much of the increased government assistance offered after 1974, only about one-half remained to further the goals of the federal subsidy program. As the data in Table 3 indicate, only about 26 percent of new government assistance received by U.S. transit systems between 1975 and 1984 ($5.5 billion) was actually used to meet expenses for operating the modest amount of new transit service that was added after federal operating subsidies were first offered. Another 24 percent ($5.1 billion) of the increase in operating assistance during this period was used to allow farebox coverage of operating expenditures to be reduced. Most of this in effect compensated for the fact that while per-passenger expenses more than doubled during the period of the federal program, typical transit fares were raised by only about one-half (as the data in Table 2 indicated). This number also includes the effect on farebox revenue of declining demand for transit service in the nation's urban areas, which continued to reduce the number of transit trips that would be made at any specific fare level during this period.

Thus during the entire period of federal participation in transit operating assistance, only about $10.7 billion of the $21.3 billion in increased government assistance (that is, subsidies above the level already provided by states and localities before federal participation began) was actually used to further the goals of adequate transit service at reasonable fares. The remaining 8 percent of the increased assistance payments made during this period (nearly $1.7 billion in 1984 dollars) was not matched by either previous unmet obligations or new expenditures by transit operators, and was thus apparently retained by its recipients to meet future expenses. However, this aggregate figure no doubt obscures considerable variation in the situations confronting individual transit operators: some were probably unable to meet all of their current expenses during certain years, whereas others may have accumulated significant amounts that remain available to meet future expenses.

As the data in Table 3 indicate, the effects on nationwide transit ridership of the service increases and fare reductions that were financed by increased government operating support were apparently modest. About 4.9 billion more transit trips were made during the period from 1975 to 1984 than would have been made if ridership remained at its level before the advent of the federal operating assistance program, representing only about a 9 percent increase in transit usage. This ridership gain was estimated by assuming that in the absence of an increase in government subsidies after 1974, ridership in each of the years between 1975 and 1984 would have remained at its (lower) 1974 level, rather than continuing on the slight upward trend that began in 1973. If the 1972-to-1974 upward trend is used to estimate ridership from 1975 to 1984 in the absence of increasing subsidy levels, the resulting cumulative increase in ridership from 1975 to 1984 is reduced to about 1.3 billion trips, or about 2 percent. Thus the amount of new assistance actually used to improve service and reduce fares to $9.00 per new rider (measured in 1984 dollars) is increased, of which $3.60 represents federal assistance.

Even this relatively modest increase cannot be attributed entirely to the federal operating assistance program because transit subsidies offered by state and local government also increased rapidly during this period, and rapid escalation in the costs of automobile ownership and travel in the nation's urban areas probably caused some drivers to switch to transit for certain trips. Still, even assuming that growth in public subsidies was responsible for all of the additional transit ridership during this period and allocating only the fraction of new subsidies (50 percent in total) that actually financed new service and lower fares, increased government operating assistance payments totaled nearly $2.20 (when measured in 1984 dollars) for each new transit trip that resulted. Slightly more than 45 percent of this amount (or almost exactly $1.00) represents federal operating assistance, and the remainder consists of additional subsidies by state and local governments above the combined level they offered before the advent of the federal operating assistance program.

Because the growth in transit ridership accompanying federal involvement in operating assistance has been so small, the program's contributions to the various other goals originally sought by its supporters--such as reducing energy consumption and air pollution, or revitalizing downtown areas--must also have been modest. This is because achieving these indirect objectives requires that operating subsidies induce substantial numbers of automobile commuters to switch to transit travel, although there is still controversy about whether carrying urban commuters by conventional mass transit rather than other modes actually does save energy or reduce air pollution. Regardless of any uncertainty about the theoretical effectiveness of transit in promoting these goals, the modest ridership gains that accompanied the federal operating subsidy program certainly mean that it has contributed little toward reducing these undesirable by-products of current urban travel patterns.

## WHY WAS OPERATING ASSISTANCE SO INEFFECTIVE?

There are several reasons why government operating assistance failed to significantly advance its advocates' original goals, and many of these reasons should have been foreseeable by transportation policymakers and transit operators. Rising labor expenses absorbed such a large part of government assistance because transit workers' compensation levels increased rapidly as assistance levels were expanded, while the productivity of transit workers continued to decline. As the data in Table 2 indicate, annual compensation per transit employee has more than doubled since the federal assistance program began in 1975, while the number of vehicle-miles of service operated per full-time transit employee has declined nearly 7 percent (despite some recent improvement). The costs of living in the nation's urban areas escalated rapidly during this period, as did workers' compensation levels throughout much of the U.S. economy (particularly those received by other unionized workers employed in providing local government services). Nevertheless, transit workers' pay levels increased significantly during the era of federal assistance even after adjusting for inflation--increasing 14 percent, as the data in Table 2 indicated--while average real earnings throughout the private sector of the U.S. economy actually declined during most of this period. Further, labor productivity in many of the nation's other transportation industries, including some faced with the same scheduling, maintenance, and administrative complexities confronting urban transit operators, continued to increased during this period (17, Table B-38).

As the data in Table 2 also indicate, utilization of transit service by urban residents improved only slightly during the period of federal support for transit operating costs. Although this did represent a reversal of its prolonged postwar decline, it was partly caused by the decline in inflation-adjusted transit fares that accompanied it. Further, its magnitude was disappointingly small considering that this period was marked by various developments that were widely expected to slow--and by some observers, even to reverse--the historical decline in demand for transit travel, including sharply rising costs for owning and operating automobiles, a slower pace of population and employment suburbanization, and decreasing real incomes for many urban households.

The failure of transit utilization to improve significantly appears partly attributable to the particular pattern of new transit service that was financed by growing operating assistance. Because total route mileage over which transit vehicles operated increased much more rapidly than did total vehicle-miles of service, the average number of vehicle-miles of transit service operated per mile of route deceased almost 25 percent between 1975 and 1984. [For more extensive discussion and documentation of these developments, see Pickrell (18).] Thus what is probably the most important dimension of public transit's usefulness as a means of urban transportation--the frequency of service it provides--declined significantly during this period. This occurred partly because schedules within the densely developed central areas of many U.S. cities, the traditional strongholds of transit service and ridership, were curtailed.

At the same time, much of the vehicle mileage added during this period represented bus service on routes that were newly extended into the expanding suburban areas of large cities, or operated by newly established public transit systems serving many of the nation's smaller urban areas. In both of these situations, travel patterns tend to be diffuse, whereas automobile ownership is generally widespread; thus the resulting demand for transit travel supports only infrequent service, most often with very low accompanying ridership (18). Because the improvement in transit utilization was so modest, increases in operating costs per unit of service were translated into similar growth in costs per passenger carried by the nation's transit systems, which more than doubled between 1975 and 1983.

At the same time, the average fare paid by transit passengers increased by only about one-half during this period, as the data in Table 2 indicate, so that the fraction of transit operators' expenses that was covered by passenger fares decreased sharply: the average fare actually paid for a transit trip declined from almost 55 percent of the expenses imposed by a typical rider during 1975 to only 39 percent of those costs by 1984. Combined state and local government subsidies increased from $0.20 to $0.71 per transit passenger between 1975 and 1984, reaching 50 percent of the U.S. industry's total revenues during 1984, while federal subsidies contributed an additional $0.15 per passenger--the remaining 11 percent of the industry's revenues--by 1984.

Yet even this substantial transfer of the burden of paying for transit service from users to taxpayers attracted surprisingly few new riders because it consisted mainly of widespread conversion to flat fare systems and marketing of unlimited-use passes to regular commuters. During the first several years of the federal subsidy program, many of the nation's largest transit operators eliminated premium fares or surcharges for trips covering long distances, travel during peak commuting hours, and trips requiring transfers--all of which were particularly costly to carry--in favor of uniform fares and free transfers (18, p.117, Table 6.2). More than three-quarters of U.S. transit systems currently offer weekly or monthly passes that entitle their holders to unlimited free rides, but are commonly priced below the equivalent of one round trip per weekday (19). The primary recipients of these substantial fare discounts, regular peak-hour commuters traveling long distances, are often those attracted to transit by its favorable travel time and service level for such trips, which they value particularly highly.

Thus these changes in fare structures usually offered particularly large reductions to riders whose travel behavior was least sensitive to fare levels, who imposed the largest share of transit systems' operating expenses, and on whom transit operators' resulting loss in farebox revenue was greatest. However, at the same time they often resulted in higher fares for many price-sensitive riders because large increases in basic fare levels were often necessary to maintain minimal farebox coverage of expenses by transit operators that eliminated premium fares and introduced discount passes. As a consequence, this widespread restructuring of fares produced disappointingly small ridership gains in most urban areas, whereas much of both federal and expanded state and local assistance was used simply to fill the growing gap between the costs of carrying transit passengers and the fare revenues they contributed.

## COMPARING TRANSIT PERFORMANCE AMONG URBAN AREAS

A number of case studies focusing on transit operators serving individual urban areas were conducted to supplement the analysis of industrywide developments in urban transit during the era of federal operating assistance. The basic criterion for selecting case studies was the availability of financial and operating data for the transit system (or, in a few cases, multiple systems) serving an urban area during both 1975 and 1983. Because virtually all U.S. urban transit systems reported these data to UMTA under its Section 15 reporting requirement during 1983, this meant that any urban area served by an operator (or operators) that voluntarily reported these data to a APTA for 1975 could be selected. Urban areas with transit systems that did so were classified by population and geographic region of the nation, from which a sample of 13--representing populations from 150,000 to several million, as well as all of the nation's major geographic regions--was selected for detailed study. The urbanized areas selected include (in alphabetical order) Buffalo, New York; Charleston, West Virginia; Chicago, Illinois; Dayton, Ohio; Madison, Wisconsin; Miami, Florida; Milwaukee, Wisconsin; Minneapolis-St. Paul, Minnesota; New York, New York; northern New Jersey; Portland, Oregon; San Diego, California; and Syracuse, New York.

The main reason for conducting these studies was to document variation in deficit growth and its sources among transit operators serving different urban areas. Generally, these case studies revealed that the nationwide aggregate estimates of transit industry performance and the uses of operating assistance reported previously conceal wide variation in cost, service, and fare changes, as well as in their contributions to rising deficits. In addition, the case studies were intended to examine whether differences among transit systems in the contributions of specific factors to rising operating deficits were associated with differences in their dependence on federal operating assistance. Table 4 gives a comparison of changes in unit operating expenses, service levels, transit utilization, and average fares during the period of federal operating assistance for 13 U.S. urban areas. As the data in the table indicate, transit operating expenses increased significantly in most urban areas, but the range of increases was wide and the distribution of individual cases across this range uniform. There was some tendency for cost increases to be more modest in larger areas (notably New York City, Chicago, and the northern New Jersey urbanized area), whereas the most rapid increases occurred in cities of diverse sizes and locations, including Miami, Minneapolis-St. Paul, Portland, and Syracuse.

There was also no obvious pattern of service increases among the 13 cases studied: three cities actually experienced significant reductions in transit service, two of which (Chicago and New York) were those where the natural market for transit service remains strong and cost increases were relatively modest. There was some tendency for service increases to be related to the pace of population growth, for example, Miami, Portland, and San Diego--all rapidly growing areas--showed rapid service increases; however some areas with declining population, such as Charleston and Milwaukee, also showed

**TABLE 4 Comparison of Changes in Transit Performance in 13 U.S. Urban Areas During the Period of Federal Operating Assistance (1975-1983)**

| | Percent Changes from 1975-1983 in: | | | |
|---|---|---|---|---|
| Urban Area | Expense per Vehicle-Mile[a] | Vehicle-Miles of Service | Passengers per Vehicle-Mile | Average Fare per Passenger[a] |
| Buffalo | 26 | 2 | -11 | -38 |
| Charleston, W. Va. | 27 | 22 | -40 | 16 |
| Chicago | 15 | -10 | 13 | -12 |
| Dayton | 17 | 86 | -41 | -3 |
| Madison, Wis. | 39 | 32 | -24 | 37 |
| Miami | 40 | 28 | -29 | 12 |
| Milwaukee | 30 | 24 | -6 | -33 |
| Minneapolis-St. Paul | 51 | 12 | -13 | 30 |
| New York City | 11 | -7 | -5 | 10 |
| Northern New Jersey | - | 28 | -6 | -18 |
| Portland, Ore. | 53 | 46 | 17 | -18 |
| San Diego | 3 | 56 | -24 | 47 |
| Syracuse | 47 | -7 | 9 | -37 |
| Average for 13 urban areas[b] | 28 | 24 | -12 | -1 |

Note: Data were calculated by the author from data reported by APTA *(20)* and UMTA *(13)*.
[a]Percent changes after adjusting for inflation.
[b]Unweighted average of individual values for 13 urban areas given in table.

rapid service increases. In any event, population alone is a poor indicator of demand for transit service, and the largest reductions in service occurred where other more important factors remained conducive to strong demand for conventional transit service.

Finally, the data in Table 4 indicate that an extremely wide range of fare policies was pursued by transit operators serving different urban areas, and that fare reductions were not generally accompanied by the intended increases in transit utilization. Transit operators serving 7 of the 13 urban areas studied reduced average fares (measured after adjusting for inflation) during the period of federal involvement--three of them by a third or more--whereas the remaining 6 increased average fare levels, again often by as much as 30 percent or more. Fare reductions were accompanied by increases in the utilization of transit service in only three of the seven cities that implemented them; in the remaining four where fares were cut, as well as in all six where average inflation-adjusted fare levels were increased during this period, utilization of transit service decreased, often substantially. These cases thus provide a few examples of improved transit utilization in response to reduced fares, but for the most part they reveal a continuing decline in urban residents' use of transit service except where fares are kept extremely low, while highway capacity remains limited, automobile parking is costly, and jobs remain highly centralized. These conditions are obviously beyond the influence of transit subsidy policy, and remain present in relatively few U.S. urban areas.

## USES OF OPERATING ASSISTANCE IN INDIVIDUAL URBAN AREAS

Table 5 gives estimates of the uses of increased operating assistance received between 1975 and 1983 by transit systems serving the 13 urban areas, as calculated by the author. As the data in the table indicate, in all but 2 of the 13 urban areas studied, meeting the increased expenses for operating the level of transit service supplied before 1975 consumed a substantial share of new operating assistance. (In Chicago, the increase in costs to operate even the reduced service level after 1975 amounted to 128 percent of new assistance received; this was financed partly by savings from eliminating some service during this period.) Thus in nearly all of the cases reviewed, the effectiveness of rising assistance levels in financing transit service improvements and fare reductions was severely compromised by their use to meet higher costs to operate existing services.

The data in the table also indicate that the use of increased operating assistance to finance new service varied widely among the 13 urban areas studied. In three cases, service levels were curtailed (as the data in Table 4 indicated), and the resulting savings were transferred to other categories of new spending. In all but one (Buffalo) of the remaining 10 cases examined, a significant share of new operating assistance made available to transit systems during this period was actually used to increase service levels; most commonly, 20 to 50 percent of increased subsidy levels funded new service, but in one case (San Diego), more than three-quarters of new assistance was used for this purpose.

The fraction of new assistance remaining to substitute for farebox effort also varied extremely widely among the cities examined. In a few cases (Madison, Minneapolis-St. Paul, and Portland), fare revenues increased even after adjusting for inflation, and the resulting proceeds were used to finance higher unit costs or added service. In Miami, only about 2 percent of new operating assistance was used to replace farebox coverage of transit costs, and in San Diego as little as 15 percent was apparently used for that purpose. However, in some other urban areas as much as 30 to 50 percent of increased assistance levels was used to compensate for revenue reductions stemming from the combination of fare cuts and ridership declines caused by external market forces. In both New York City and Chicago, amounts equal to large proportions of new operating assistance were used to replace farebox revenues, but as discussed previously these were partly financed by cost savings that resulted from service reductions.

**TABLE 5 Estimated Uses of Government Assistance Recieved by Transit Operators in 13 U.S. Urban Areas (1975-1983)**

| | Percent of New Operating Assistance Used To: | | |
|---|---|---|---|
| Urban Area | Maintain 1974 Service Level | Add New Service | Substitute for Farebox Effort |
| Buffalo, N.Y. | 44 | 4 | 52 |
| Charleston, W.Va. | 41 | 27 | 32 |
| Chicago, Ill. | 128 | -91 | 63 |
| Dayton, Ohio | 18 | 48 | 34 |
| Madison, Wis. | 65 | 40 | -5 |
| Miami, Fla. | 63 | 35 | 2 |
| Milwaukee, Wis. | 46 | 31 | 23 |
| Minneapolis-St. Paul, Minn. | 89 | 19 | -8 |
| New York City, N.Y. | 72 | -45 | 73 |
| Northern New Jersey | – | 42 | 58 |
| Portland, Oreg. | 68 | 41 | -9 |
| San Diego, Calif. | 8 | 77 | 15 |
| Syracuse, N.Y. | 77 | -8 | 31 |
| Average for 13 urban areas | 55 | 17 | 28 |
| All U.S. urban areas[a] | 46 | 28 | 26 |

[a]Percent of assistance actually matched by new expenditures; differs from entries in Table 3 because not all new assistance was used for one of these three purposes.

## EVALUATING FEDERAL OPERATING ASSISTANCE

The demise of privately profitable, large-scale conventional mass transit service in the U.S. cannot reasonably be attributed to federal transit subsidy policies, and particularly cannot be blamed on the federal operating assistance program, as some of its harsher critics have suggested. Federal capital assistance did help finance some public takeovers of unprofitable or bankrupt transit operators by local government agencies between the time it was first offered in 1964 and the 1975 advent of the Section 5 operating assistance program, while federal highway investment policies may have contributed to the changing patterns of transit ridership that made many private systems unprofitable. Nevertheless, public ownership and operation of the nation's transit industry was firmly entrenched before the advent of the federal operating assistance program.

Further, comparing changes in transit industry performance during various periods does not reveal any pronounced difference between the effects on transit performance of support for transit from federal versus lower levels of government. The modest differences in basic cost, productivity, and other performance trends in the industry between the years before federal assistance began and the decade for which it has been available were largely confined to the start-up years of the Section 5 program (1975 to 1980) and were at most only partly attributable to federal assistance itself. This history reveals that simultaneous rapid growth in operating assistance from every level of government, as occurred from 1975 to 1980 when federal, state, and local support all expanded rapidly, was able to reverse temporarily the historical patterns of declining transit service and increasing fares. However, it also reveals that the new service and lower fares financed by rapidly growing government support produced only modest growth in mass transit ridership, which was also confined to the brief period of simultaneously expanding support by all levels of government. Even this modest increase in transit ridership was not entirely attributable to growing government assistance; actually, the federal assistance program was probably responsible for relatively little of it.

Federal operating assistance was ineffective in promoting increased ridership and the other objectives sought by its advocates partly because much of it simply financed escalating expenses for operating existing service. Some of the increase in transit labor costs--although probably very little, judging from the sluggish pace of wage growth in other industries during this time--may have been necessary to match pay rates in other sectors of the economy, whereas some probably resulted from labor practices and administrative procedures mandated by Congress as conditions for receiving operating assistance; certainly the major increase in energy prices was out of the control of transit operators. Nevertheless, transit management practices and service polices must also have contributed significantly to the rapid escalation in the industry's operating expenses because growth in expenses per unit of service outpaced even the increases in prices the industry paid for its major operating inputs.

Subsidies were also ineffective because transit ridership proved surprisingly insensitive to the service increases and fare reductions that the remaining government assistance actually financed. Certainly the extension of transit service to outlying suburban areas and smaller cities reflected the changing distributions of population and employment in U.S. cities and among regions of the country, but transit utilization at the urban densities that characterized these newly served areas was foreseeably low. At the same time, widespread conversion to flat fare systems and the introduction of commuter passes targeted fare reductions on travelers who were predictably least responsive to them, and who were most expensive for transit operators to serve.

Finally, expanding government assistance was ineffective in promoting transit use because the natural market for conventional mass transit service in U.S. urban areas continued to decline, as it has throughout virtually the entire 20th century. Declining demand for mass transit travel is the product of rising incomes of urban residents, continuing decentralization of population and employment within the nation's urban areas, and changes in the demographic structure of U.S. households. None of these is likely to be significantly altered by federal transportation policies, and it may be undesirable to attempt to modify them using available policies.

At the same time, the real costs of tailoring conventional mass transit services to meet the evolving spatial and temporal patterns of urban travel demand produced by these forces are unavoidably increasing. Geographic dispersion and extreme peaking in travel patterns necessarily reduce labor productivity in transit operations, while requiring higher pay rates to compensate workers for accepting undesirable work schedules, thus compounding the problems already faced by operators of a labor-intensive service in an economy characterized by rising wage costs. Together, these complications seriously undermined the effectiveness of government subsidies in promoting increased ridership and the variety of related objectives originally sought by the advocates of federal assistance. Federal operating assistance was probably no more ineffective than subsidies offered by local or state governments. Some evidence even suggests that assistance financed by dedicated state and local tax sources is even more likely to be absorbed by increasing labor compensation or other expenses than are subsidies appropriated from general government revenues such as federal assistance under the Section 5 and Section 9 programs (18,pp.84-89;21,pp.32-35).

Thus the basic problem with the federal operating assistance program was neither that it hastened the demise of a viable private industry, nor that it compromised the U.S. urban transit industry's operating performance. Rather, the problem with federal transit assistance continues to be that it is a costly and predictably ineffective means by which to promote a catalog of poorly articulated, empirically unrealistic, and perhaps even undesirable goals. Because of the high cost of accommodating it, increased mass transit ridership is not by itself necessarily a desirable objective. There remains considerable doubt whether promoting conventional transit actually can save energy or reduce air pollution; and there is no evidence that publicly subsidized mass transit service is sufficient or even necessary for the continued viability of urban areas. A program that attempts to achieve these objectives indirectly by subsidizing operators of conventional mass transit service appears destined to remain not only unnecessarily costly, but also a disappointingly ineffective element of federal transportation policy.

## REFORMING FEDERAL TRANSIT POLICY

Two possibilities for increasing the effectiveness of federal transit policies appear particularly promising, but both require a major departure from the traditional attitudes toward and functioning of current federal transit assistance programs, and will thus no doubt be politically difficult to implement.

First, designating recipients of federal operating assistance in individual urban areas other than each city's major transit authority is a promising way to introduce new incentives for local transportation planners and managers to evaluate the relative importance of alternative service provision arrangements and fare structures, as well as to adapt the services they provide to different transit markets within individual urban areas. The regional transportation commissions that already exist in a number of metropolitan areas are logical candidates for this role, and some of them (such as the Detroit area's Southeastern Michigan Transportation Authority and Virginia's Tidewater Transportation District Commission) have already assumed it with apparently successful results. This strategy is advocated particularly forcefully in Lave (22, Chapter 1).

These agencies have responded to the political pressures to maintain geographically widespread transit services that inevitably arise in large metropolitan areas by using their federal (and other) subsidies to finance services that are more carefully tailored to localized travel patterns and cost circumstances in different parts of their districts than is typically the case. In doing so, they have partly avoided the tendency shown by most transit authorities that receive subsidy funds directly simply to extend conventional bus service to all reaches of the urban area, usually at the same fare charged all other riders in their service areas.

They have done so partly by contracting out various activities--including the actual operation of some services--to suppliers other than the dominant local transit authority, doubtless an unpopular strategy with these often politically powerful agencies. However, this has almost certainly been to the benefit of both service recipients and those local taxpayers who are recurringly called on to finance the bulk of the transit authority's deficits [see J.C. Echols's Use of Private Companies To Provide Public Transportation Services in Tidewater, Virginia, in Lave (22, Chapter 4)].

Designating recipients of federal assistance other than transit authorities is also a promising way to introduce an important new element into local transit service planning and operating decisions: competition among potential suppliers of transit services to these different markets. This could take the form of competitive bidding among suppliers for renewable but perhaps exclusive franchises to serve particular routes or areas, which would encourage not only efforts to improve productivity and control costs, but also to introduce higher quality transit services and various other adaptations to localized circumstances. Even under such a system, the large public transit authorities that currently operate in most metropolitan areas would probably continue to provide much of the nation's conventional transit service; however, they would face heightened competition from prospective private operators for their right to do so.

Although the recent public debate has focused almost exclusively on methods to privatize the provision of urban transit services, it is this presence of competition--even in its indirect form of competitive bidding for renewable franchises--that will encourage both public and private operators to operate efficiently and tailor their services to urban residents' travel needs. Without such competition, there is no inherent reason that private operators would deliver the current pattern of transit service any more productively than is currently done by public authorities. However, in its presence efforts to develop new services, including some that might not utilize conventional transit vehicles running on fixed timetables, would no doubt also increase as long as the subsidy-receiving agency remained willing to consider seriously authorizing their introduction.

The advantage of a more competitive system of providing urban transit services--an increased emphasis on meeting urban residents' demands for varied transportation services--should not be dismissed lightly because the public authorities that dominate the current system engage in so astonishingly little of it. For example, 18 of the nation's largest transit authorities together spent less than one-half of one percent of their total budgets on market research and service planning during 1983. It is difficult to determine how this compares with other transportation or service industries, but it does appear to be very low (see paper by Booth elsewhere in this Record).

A second change that would help rationalize current federal transit policy would be to combine the currently separate capital and operating assistance programs into a single transit block grant to be distributed among urban areas according to some agreed-on formula. The recent combination of operating assistance payments with formula-based grants for capital projects (under the UMTA Section 9 program) represents a fledgling but potentially significant step in this direction. Unfortunately, however, the new arrangement retains the basic distinction between assistance for capital investments and operating expenses that is responsible for many of the program's current problems.

Removing this distinction entirely will be necessary to neutralize the powerful incentive to overcapitalize but undermaintain the nation's transit systems that is now offered by the independent treatment of capital and operating assistance. Local political officials and transit planners respond to these incentives in a predictable but wasteful effort to substitute capital, which is made artificially cheap by the generous federal matching shares (up to 80 percent) on transit construction projects and vehicle purchases, for labor that has been made artificially expensive by a decade of unrestricted subsidies for operating expenses, much of which has found its way into escalated labor costs.

An even farther-reaching rationalization of current federal transportation policies--and, over the longer term, the shapes of local transportation systems they foster--would result from combining federal transit and highway assistance programs into a single transportation grant, to be spent largely at the discretion of local planners and political officials. Although this is a laudable longer-term policy objective, the overdue step of consolidating current federal transit assistance into a single unified program doubtless provides a sufficient political challenge to occupy federal policymakers for the foreseeable future, and in any event is probably a prerequisite to the more ambitious step of integrating urban highway and transit aid. Together with redesignating as recipients of such unified grants local agencies that view the improvement of regionwide transportation services as their mandate--rather than simply the extension or preservation of publicly operated, conventional transit service at uniformly low fares--this would represent a valuable first step toward a federal policy that fosters more productive, diverse, and useful transit service.

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# Transit Route Characteristics and Headway-Based Reliability Control

MARK ABKOWITZ and JOHN TOZZI

ABSTRACT

Previous research has provided a method for improving transit service reliability through headway-based control by using models developed and validated from empirical data. In implementing this strategy, identification of transit routes the characteristics of which can potentially yield significant reductions in passenger wait time is a critical issue. In this paper, several characteristics of the transit route are examined to identify the most appropriate conditions under which headway-based control should be exercised. The paper includes an evaluation of several boarding and alighting profiles that typify ridership characteristics of metropolitan bus systems, sensitivity analyses to determine if small boarding changes or increased volumes affect the benefits of headway-based control, the effects of changes in the weight assigned to passengers detained at the control stop compared with those waiting downstream, the impact of initial headway variation at the route origin, and the effect of parking considerations along a route. The results indicate that profiles with passengers boarding at the middle and alighting at the end of a route produce the most significant savings in passenger wait time when headway-based control is implemented. Improvements in wait-time reduction diminish as more passengers board at early stops and are enhanced as the total ridership increases. Increases in the initial headway variation and amount of parking permitted along a route help deteriorate route reliability and thus improve the effectiveness of implementing a control strategy. The effect of assigning more importance to passengers detained at the control point compared with passengers waiting downstream of control decreases the effectiveness of implementing a headway-based control strategy, as expected. Collectively, the findings are intuitively appealing and suggest preferred conditions under which headway-based control is a viable operating strategy.

Previous research concerning transit service reliability has produced a method for maintaining regular service intervals through headway-based control by using models developed and validated from empirical data.

A headway-based strategy consists of holding a bus at a specified location for a certain amount of time, known as the threshold value (X). If the headway between the previous bus and the arriving bus is less than X, the arriving bus is held up to X. If this headway is greater than X, the arriving bus is not held. Headway-based control is most suitable for routes operating with short, uniform headways. When headways are short and uniform, it is assumed that passengers arrive more randomly at stops and that they are more concerned with the headway than with the schedule. Similarly, operators are concerned about keeping vehicles evenly spaced so that vehicle availability remains stable and the need to assign additional vehicles to a route is diminished.

Considerable detail on a decision algorithm for headway-based control has been documented previously in the literature, and thus will only be described briefly in this discussion (1). The methodology consists of five sequential steps:

1. Derivation of mean running time,
2. Estimation of running time variation,
3. Computation of headway variation,
4. Determination of passenger wait time, and
5. Implementation of optimal control strategy.

The first four steps represent the derivation of models developed and validated from empirical data of bus operations in metropolitan Cincinnati and Los Angeles. These model outputs feed into Step 5, where the feasibility of control is determined. If control is deemed effective, the optimal stop and threshold levels are determined. This is based on an algorithm designed to minimize the following objective function:

$$TW = \sum_{i=1}^{j-1} (n_i \times \bar{w}_i) + [b_j \times d_j(x)] + \sum_{i=j}^{N} (n_i \times \bar{w}_i) \quad (1)$$

where

- $TW$ = expected total wait time on route,
- $j$ = control stop,
- $n_i$ = number of passengers boarding at stop i,
- $\bar{w}_j$ = average wait time at stop i,
- $b_j$ = number of passengers on board at stop j,
- $d_j(x)$ = expected delay at the control stop for the threshold of x,
- $x$ = threshold value, and
- $N$ = total number of stops on route.

Although minimization of total wait time is the objective of the algorithm, achieving this objective also creates a more regular interval of vehicle ar-

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LIST OF EFFECTIVE CONTROL STOPS BY ORDER

STOP 6,  THRESHOLD  4.00 MIN,  REDUCTION  11.82 MIN,  %REDUCTION  8.37%

STOP 5,  THRESHOLD  4.00 MIN,  REDUCTION  11.28 MIN,  %REDUCTION  8.00%

STOP 4,  THRESHOLD  4.00 MIN,  REDUCTION  10.67 MIN,  %REDUCTION  7.57%

STOP 3,  THRESHOLD  4.00 MIN,  REDUCTION  10.17 MIN,  %REDUCTION  7.21%

STOP 2,  THRESHOLD  4.00 MIN,  REDUCTION  9.51 MIN,  %REDUCTION  6.74%

STOP 7,  THRESHOLD  2.25 MIN,  REDUCTION  2.27 MIN,  %REDUCTION  1.61%
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**FIGURE 1 Sample output for headway-based control.**

rivals, which reduces the number of vehicles required to effectively cover a route. Thus, the wait-time reductions that are reported subsequently in this paper should be considered as a measure of both passenger benefit and operator benefit.

To facilitate policy analysis, the entire methodology has been coded in PASCAL for microcomputer application. For each stop, the user defines the number of boardings and alightings, distance and number of intersections from the previous stop, direction and time period of travel, and, if available, the percentage of on-street parking allowed from the previous stop. The user is also prompted for additional information concerning the weight assigned to passenger delay for persons on-board a vehicle if control is implemented compared with passenger wait time for persons waiting to board the vehicle downstream of the control stop. This latter consideration allows for the specification of different impedances for different types of passenger delay.

The model output includes a priority listing of the most effective control stops on the route with their corresponding threshold values and the benefits of control over the no-control case [see Figure 1; reduction = total passenger wait-time reduction, threshold = threshold value (X), and headway = 4 min]. A previous validation of the methodology and algorithm was conducted by using data from the Southern California Rapid Transit District (SCRTD) and reviewing the predicted results with the SCRTD Scheduling Department. For each route analyzed, the percentage of reduction in the total wait time predicted by the methodology was considered reasonable.

The primary objective of continuing this research was to evaluate the sensitivity of headway-based control to varying boarding and alighting profiles, headways, and other characteristics of route operations. The study also involved separate analyses concerning the effect of changing the initial headway variation (to reflect bus dispatching irregularities) and the weight assigned to passengers detained at the control stop compared with passengers waiting downstream of the control point. An interest in determining which factors produce significant reductions in total passenger wait time under headway-based control was a motivating factor in the research.

## ANALYSIS RESULTS

The following general boarding and alighting profiles were established to investigate the impact of ridership profiles on the effectiveness of headway-based control (see Figure 2):

- Boarding at the beginning of the route and alighting at the end.
- Boarding at the beginning of the route and alighting at the middle and end.

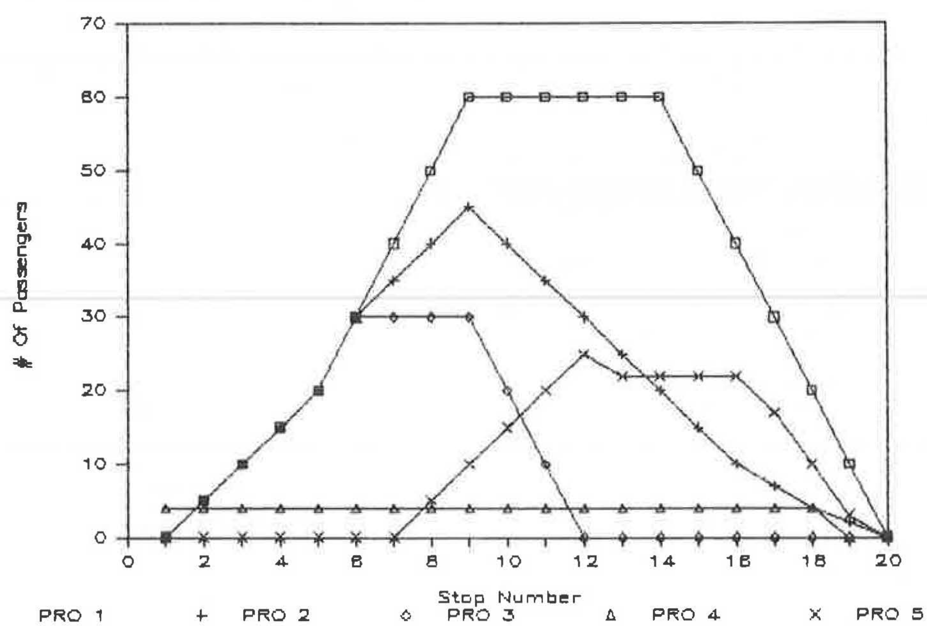


**FIGURE 2 On-board profile of passengers for each scenario.**

• Boarding at the beginning of the route and alighting at the middle.

• Boarding and alighting uniformly along the route.

• Boarding at the middle of the route and alighting at the end.

The first scenario represents routes that originate in the suburbs and end in the central business district (CBD) during the morning peak period and originate in the CBD and end in the suburbs during the afternoon peak period. Scenario 2 represents routes similar to Scenario 1; however, some passengers on this type of route alight before the CBD during the morning peak period or before the suburban route terminus in the afternoon. Routes that originate in the suburbs and pass through the CBD in the middle of their route are represented by Scenario 3. The fourth scenario represents a type of route operating solely in the CBD, where passengers are uniformly boarding and alighting at each stop. The fifth scenario represents routes that start before the CBD and end in the suburbs during the afternoon peak period.

For the purpose of creating a uniform basis of comparison, evaluation of each boarding and alighting scenario was conducted by using a 20-stop route with a total of 60 passengers boarding and alighting; all other parameters were held constant. When control is effective, the optimal control stop is identified by the algorithm and its corresponding threshold value is computed. The threshold value is highly dependent on the number of passengers on board at the control stop because they will incur delay time if the bus is held. Threshold values usually range from the scheduled headway to one-half of the headway for effective control strategies. When control is not deemed to be effective, the threshold value approaches zero.

Headway-based control proved to be ineffective for those profiles that had passengers boarding at the beginning and alighting at the end, middle, or middle and end of a route. For Scenarios 1 to 3, passengers are boarding the bus during the first few stops. Regardless of where these passengers alight, the reduction in total passenger wait time associated with implementing a control strategy is negligible. Control is not effective under these conditions because of the lack of passengers boarding downstream and the relatively large number of people on board the bus at any potential control point. If there are no passengers waiting downstream of the initial boardings, there is no benefit to passengers waiting downstream by holding buses. Rather, additional delays are sustained by passengers detained on board the bus at the holding point. These results were consistent across headways ranging from 4 to 10 min. Scenarios 4 and 5 demonstrated encouraging results and warranted additional examination.

Unlike the first three scenarios, the uniform boarding and alighting profile included passenger boardings at almost every stop (see Figure 3; in this figure, headway = 4 min; control stop = 12; X = 1.75 min; and percent reduction = 1.00). Reductions in wait time occurred for this profile because enough passengers were waiting downstream who would benefit from the use of a control strategy. However, these reductions were low because the number of passengers waiting beyond the control point is comparable to the number of passengers detained at the control stop. The use of control is sensitive to passengers detained; therefore, for control to be effective, the number of boardings after control must be large enough to outweigh the disadvantage to those passengers detained.

The absolute and relative reductions were found to be dependent on the scheduled headway because better results occurred for smaller headways. This is probably due to increased probabilities of bunching under high-frequency conditions.

As the number of passengers using the route increased to a total of more than 60 passengers boarding and alighting, the wait-time reductions of headway-based control improved significantly (see Table 1). This is due to the increase in running time uncertainty from a greater number of boardings and alightings. It suggests that implementing headway-based control for uniform boarding profiles may be more feasible on routes containing large ridership populations.

A separate analysis was performed using Scenario 4 to determine the effect of changing the weight

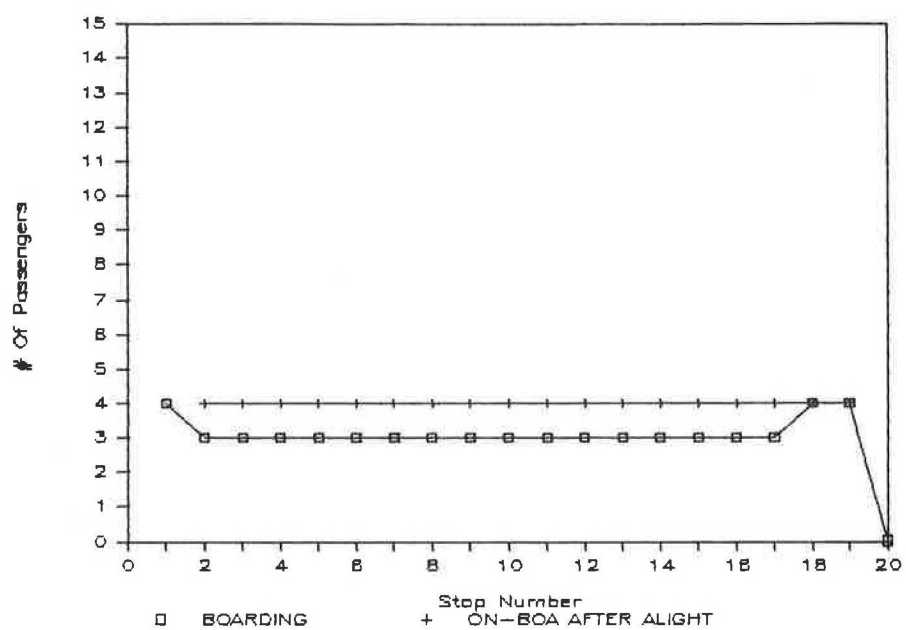


FIGURE 3 Effect of uniform boarding and alighting on headway-based control.

TABLE 1 Effects of Increased Ridership on Headway-Based Control: Percentage of Reduction in Wait Time

| No. of Passengers Along Route | Headway (min) | | | |
|---|---|---|---|---|
| | 4.00 | 6.00 | 8.00 | 10.00 |
| 60 | 1.00 | 0.49 | 0.07 | 0.00 |
| 120 | 1.59 | 0.97 | 0.45 | 0.08 |
| 240 | 2.71 | 1.93 | 1.22 | 0.71 |

assigned to delay to passengers detained at the control stop compared with passenger wait time downstream of control. It was found that the effectiveness of headway-based control decreases significantly as more importance is given to passengers on board at the control stop (see Figure 4).

Scenario 5 consisted of passengers boarding at the middle of a route and alighting at the end. This scenario produced the most significant reductions in passenger wait time when headway-based control is implemented. All of the passengers boarding were

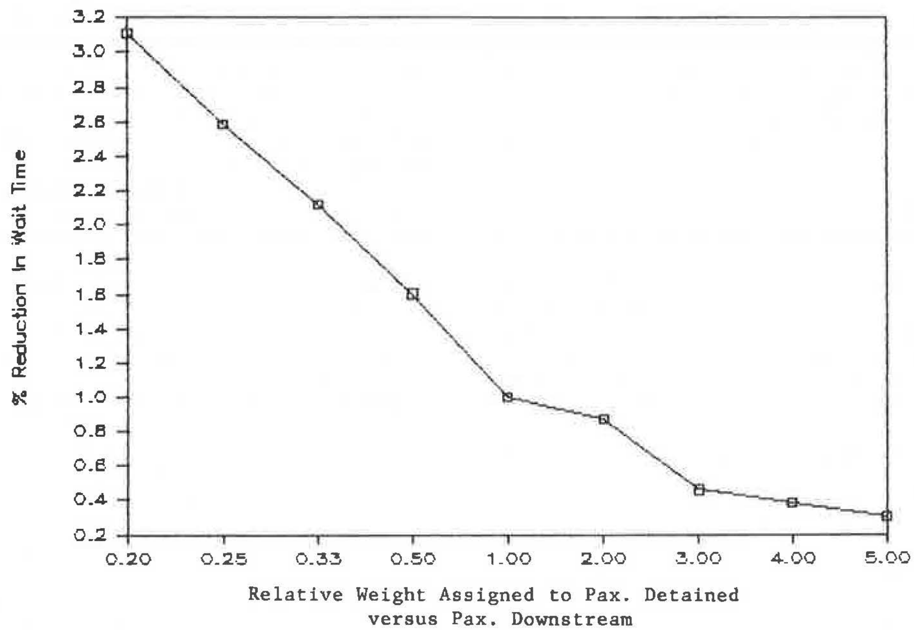


FIGURE 4 Effect of varying assigned weight of passengers detained at the control stop.

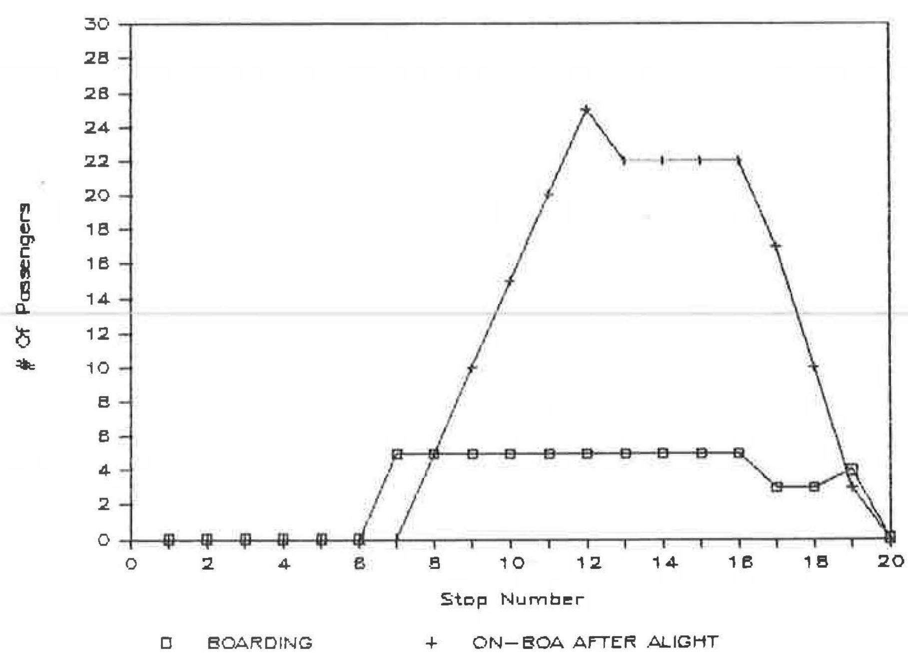


FIGURE 5 Impact of headway-based control for Scenario 5.

TABLE 2 Effects of Boarding Changes on Headway-Based Control

| Boarding Profiles[a] | Control Stop | Threshold (min) | Reduction (%) | Reduction (min) |
|---|---|---|---|---|
| Original data | 6 | 4.00 | 8.37 | 11.82 |
| 1 person at Stop 1; 4 people at Stop 7 | 6 | 4.00 | 5.40 | 7.61 |
| 2 people at Stop 1; 3 people at Stop 7 | 6 | 3.25 | 2.90 | 4.09 |
| 3 people at Stop 1; 2 people at Stop 7 | 6 | 2.75 | 1.98 | 2.79 |
| 4 people at Stop 1; 1 person at Stop 7 | 6 | 2.50 | 1.46 | 2.06 |
| 5 people at Stop 1; zero people at Stop 7 | 7 | 2.25 | 1.34 | 1.89 |

[a]Number of people boarding at each stop.

TABLE 3 Effect of Initial Headway Variation on Headway-Based Control

| Initial Headway Variation ($min^2$) | Reduction (%) | Reduction (min) |
|---|---|---|
| 1.42 | 8.37 | 11.82 |
| 1.59 | 9.13 | 13.04 |
| 1.77 | 9.90 | 14.30 |
| 1.96 | 10.67 | 15.60 |
| 2.15 | 11.45 | 16.93 |

downstream of the initial stops, allowing control to result in excellent wait-time savings to passengers with no delay to on-board passengers (see Figure 5; in this figure, headway = 4 min; control stop = 6; X = 4.00 min; and percent reduction = 8.37).

Because this profile produced the most meaningful results, a sensitivity analysis was conducted to evaluate the effect of more disaggregate changes to ridership profiles by assigning passenger boardings closer to the route origin. Modifications were made to the original boarding data of Scenario 5 (see Table 2), and the impact of headway-based control was reevaluated. By using scheduled headways of 4 min and moving one passenger from Stop 7 to Stop 1, the percentage of wait-time reduction decreased from 8.37 to 5.40. As more passengers were moved to Stop 1, the reduction in wait time for those downstream decreased and the threshold value, which affects those on board, also decreased. These results further substantiate that control strategies can incur significant savings when there is a small number of passengers on board at the control stop and when the majority of passengers board downstream of the control point.

Because the methodology discussed in this study assumes that buses are dispatched from the route origin on time and arrive at their initial stop with a low headway variation, a separate analysis was performed to evaluate the effects resulting from larger initial headway variation. The evaluation results presented in Table 3 indicate that increased headway variation associated with the initial stop along a route helps deteriorate route reliability and therefore enhances the benefits of implementing a control strategy.

Additional analyses using Scenario 5 data were performed to evaluate the effects resulting from changes in the percentage of on-street parking allowed between stops. With all other inputs held constant, including a 10-min headway and a distance between stops equal to 0.5 miles, the percentage of parking allowed on the link was increased from 10 to 90. It was found that increasing the percentage of parking allowed along a route also increases the percentage of passenger wait-time reduction using headway-based control (see Figure 6). As the percentage of parking along a route increases, headway variation also increases because the bus is being subjected to automobiles entering the flow from parking spaces, drivers opening doors into traffic, and space limitations associated with boarding and alighting of passengers. All of these factors con-

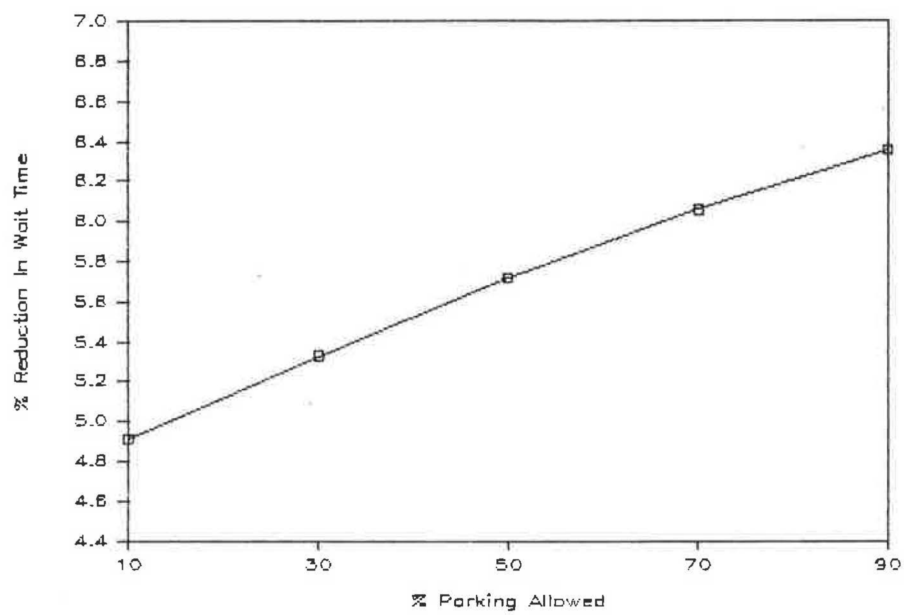


FIGURE 6 Effect of parking restrictions on headway-based control.

tribute to a deterioration of route reliability and thus an increase in passenger wait time. Therefore, the benefits of implementing headway-based control are enhanced by an increase in parking allowed along a route.

## CONCLUSIONS

Several findings can be reported from this research activity. Wait-time reduction effectuated by headway-based control is strongly influenced by the location of passenger boardings and alightings, total ridership on the route, scheduled headway, the relative weight assigned to passengers detained at the control stop, initial headway variation, and percentage of on-street parking permitted.

Profiles that consist of passengers boarding at the beginning of a route and alighting anywhere from the middle to the end produce little or no savings in wait time if headway-based control were to be implemented. Uniform boarding profiles exhibit marginal reductions in wait time unless the route ridership is large or the importance assigned to passengers detained at the control stop is less than the importance assigned to passengers waiting downstream of the control stop. The best results occur for profiles in which the number of passengers on board at early stops is low and thus the majority of passengers is boarding at the middle of the route and alighting at the end. Increases in the initial headway variation and amount of parking permitted help deteriorate route reliability, which enables headway-based control to be more effective. The significance of increasing the initial headway variation demonstrates the importance of dispatching vehicles from the route origin at regular intervals.

Collectively, the findings are intuitively appealing and suggest preferred conditions under which headway-based control is a viable operating strategy. The results can be used by transit managers and planners to identify candidate routes for headway-based control. The methodology described will be implemented shortly by a transit property in the northeast United States that is interested in responding to service reliability problems being experienced on several routes. In the course of that activity, the benefits of headway-based control will be evaluated relative to current route operating strategies.

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# Day-of-Week and Part-of-Month Variation in Bus Ridership: Empirical Results

MARK R. McCORD and LI-HUNG CHENG

ABSTRACT

Results from a study of bus ridership during a 2-year period on the Central Ohio Transit Authority indicate that ridership depends systematically and strongly on the day of the work week and on the part of the month. Ridership tended to decrease from Monday through Friday and was higher at the beginning than at the end of each month. Possible causes of these effects are presented and their implications for transit planning are discussed.

The number of trips made in an urban area varies in time. More work trips occur during certain times of the day than during others, and fewer trips occur on weekends. Sickness may cancel different numbers of individual work trips on different days. Shopping and recreational trips from the same origin to the same destination may not be made every day; when they are made, they may be made at different times of the day. Vacation trips are more prevalent during certain seasons than during others. When variability in modal choice decisions is added to this variability in trip-generating characteristics, it stands to reason that the number of trips made using transit on a certain route will vary by season, by day, and by time of day.

Recognizing and understanding this temporal variability in transit patronage is important in transit planning for several reasons. Headways can be increased to balance decreasing demand, as is typically done during off-peak, weekend, and holiday periods. Medium-range scheduling and routing decisions are based on estimates of current and past patronage. These estimates are derived from samples taken during specific time periods (1,2). If the estimates are to be useful for other or longer time periods, the characteristics of the periods during which the samples were taken must be considered (3). Similarly, the results of a sample on socioeconomic characteristics of the riders could be biased if the sample were conducted at times when certain groups were over- or underrepresented.

A better understanding of the reasons for temporal variability in transit patronage could also permit a better marketing of transit services. Scheduling and routing decisions would be part of this marketing package. Temporal pricing might be used to induce ridership during price-elastic periods and to increase revenues during price-inelastic periods (4). Service may be improved in those attributes that cause individuals who would otherwise use transit to switch modes or to forsake trips at certain times.

It is widely accepted that transit ridership depends systematically on the time of the day and on whether the day is a workday. It is also suspected that systematic variability in transit patronage occurs on different weekdays (2,3). However, no formal documentation of this suspected day-of-the-week effect appears to exist. Personal discussions with transit operators have revealed a suspicion that ridership is greater at the beginning than at the end of the month. But again, the authors know of no empirical evidence documenting this part-of-the-month effect.

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Presented in this paper is empirical evidence that indicates that bus ridership on the Central Ohio Transit Authority (COTA) system depends on the day of the week and on the part of the month. To the authors' knowledge, it represents the first formal documentation of such empirical evidence. The difference between two days of the same work week is only between 3 and 4 percent on the average. Yet the difference occurs so systematically that a clear trend is denoted: as the week progresses, ridership decreases. The difference between the beginning and end of the month is much larger, more than 10 percent on the average. This comparison also indicates a strong trend: ridership is higher at the beginning of the month than at the end.

In the next section, the data used in the study and the methods needed to investigate day-of-the-week and part-of-the-month effects are described. In Section 3, the results indicating these effects are presented. In the final section, possible causes of the effects are speculated on and their practical implications for transit planning are mentioned.

## STUDY DESIGN

### Objective and Definitions

The objective of the study was to investigate variability in transit ridership as a function of the day of the week and part of the month. If such variability exists, it should be considered when designing sampling and marketing strategies. It would also influence the way in which transit agencies estimate daily patronage from more aggregate data such as monthly passes. If such variability does not exist, the current work on developing sampling strategies to account for it would be unwarranted. Also, it is argued that the existence of a day-of-the-week effect would influence the analytical methods necessary to investigate a part-of-the-month effect and vice versa.

Day-of-the-week effect means a cyclic pattern in transit patronage that is correlated with the work week. Specifically, this effect will be said to exist if the level of transit patronage on a given day of the work week--Monday, for example--differs systematically (across weeks) from the level of transit patronage on the other days of the same work week.

Part-of-the-month effect means a cyclic pattern in transit patronage that is correlated with the calendar month. Specifically, this effect will be said to exist if, when the month is divided into a given number of periods, which do not necessarily exhaust the month but which are similarly defined from one month to the next, the level of transit patronage during one of these periods differs systematically (across months) from the level of transit patronage during the other periods of the same month.

## Data

To investigate these effects, systemwide bus revenue data furnished by COTA were used. The data covered a 2-year period, from January 1, 1982, through December 31, 1983. The period from November 22 to December 10, 1982, was excluded because of a drivers' strike.

COTA maintains daily systemwide records for a number of patronage statistics. COTA estimates daily patronage by summing the following:

1. An estimate of the number of daily cash (fare box) passengers derived from fare box revenue by using an average fare procedure (2);
2. The number of passengers buying single-use tickets;
3. An estimate of daily usage by monthly pass purchasers obtained from a linear formula by using assumed parameters (which do not currently account for day-of-the-week or part-of-the-month variation); and
4. An estimate of the number of nonrevenue-generating passengers obtained from the number of revenue-generating passengers by using a fixed percentage.

In this procedure, then, the only data obtained directly for a given day are the fare box revenue and the number of tickets sold.

COTA also records daily ticket revenue. These data are obtained without assumption by multiplying the price of each ticket category by the number of tickets sold daily in each category. By using only direct empirical data--data that are not derived by using assumed parameters--the most information on daily variation in patronage is obtained by summing the daily fare box (cash) and ticket revenues. These are the data that were used for analysis.

## Representative Statistics

To investigate variability according to the day of the week, one could compare the averages, taken over the 2-year period, of the cash and ticket revenue for each weekday. (The authors shall not be concerned with weekends and holidays in this study because the decreased patronage on these days is well accepted and because there are as well significant differences in the service supplied.) These averages shall be denoted $\bar{X}$, where X = M, T, W, Th, F, respectively, representing the consecutive days of the work week.

It would be surprising if the averages for two different days of the week were identical. However, to determine if they were markedly different, the variances of the distributions of the revenue data for individual weekdays, Xi, during the 2-year period about the sample mean, $\bar{X}$, would have to be considered. However for data such as those of the authors, serial correlation might inflate the variances. Specifically, it would be possible that for all weeks, i, the revenue data for a given day of the week, Xi (e.g., Monday), would be higher than those for a different day, Yi (e.g., Tuesday). This would lead not only to $\bar{X} > \bar{Y}$, but to Xi > Yi for all i, which is exactly the day-of-the-week effect. Yet if revenue figures for various weeks differed by enough--perhaps because of a seasonal effect (5) or part-of-the-month effect--the variances of the distributions of the Xi's and Yi's might be great enough to make the differences between the means, $\bar{X} - \bar{Y}$, appear to be insignificant. Indeed, a Durbin-Watsen (6) test indicated that this type of serial correlation did exist in the authors' data set (5).

To reduce this problem, the authors analyzed the difference in the cash and ticket revenues between pairs of weekdays in a given week. That is, they defined

$$DXYi = Xi - Yi \quad (1)$$

where Xi and Yi are the cash and ticket revenues for two different days in a given week, i. To avoid double counting, this difference, DXY, was taken for all combinations of weekdays such that X occurred before Y in the week. For example, when X represented Monday, DXY was formed for Y representing Tuesday, Wednesday, Thursday, and Friday; when X represented Thursday, DXY was only formed for Y representing Friday. This also ensured that a positive (negative) value of DXY indicated that the revenue data of the earlier day of the week was higher (lower) than that of the later day of the week.

A part-of-the-month effect would influence the value of these DXYi's where X and Y represented 2 days during the same week but during different months. Specifically, if the first part of the month exhibited patronage significantly higher or lower than that of the last part of the month, the difference between Xi and Yi would be influenced when Xi was the final X in a month and Yi was the first Y in the following month. To avoid this problem, any DXYi's where Xi and Yi were in different months were eliminated from consideration. A Durbin-Watsen test indicated that the authors' final set of DXYi's did not exhibit serial correlation.

To compare the patronage differences as a function of the part of the month, the authors formed the average of the cash and ticket revenues over the first 5 weekdays of each month and the average of the cash and ticket revenues over the last 5 weekdays of each month. That is, the authors determined

$$Bj = (Mbj + Tbj + Wbj + Thbj + Fbj)/5 \quad (2)$$

$$Ej = (Mej + Tej + Wej + Thej + Fej)/5 \quad (3)$$

where Mbj, Tbj, Wbj, Thbj, Fbj represent, respectively, the cash and ticket revenues for the first (beginning) Monday through Friday of month j; and Mej, Tej, Wej, Thej, Fej represent, respectively, the cash and ticket revenues for the last (ending), Monday through Friday of month j.

By including an observation for each weekday, the impact of the day-of-the-week effect on the statistics representing the beginnings and ends of each month was reduced. If a holiday occurred on any of the first or last 5 weekdays of the month, the holiday was eliminated from the average. The results were so strong for the part-of-the-month effect that it did not appear necessary to control for a bias related to day-of-the-week effect induced when eliminating certain days (e.g., Monday) more often than others.

Variation in patronage among different months would increase the variance in the distributions of the Bj's and Ej's. Therefore, the difference between the statistics representing patronage at the beginning and end of month j (DBEj) was taken:

$$DBEj = Bj - Ej \quad (4)$$

## RESULTS

### Day-of-the-Week Effect

In Table 1, the average, taken over the 2-year period, of the fare box and ticket revenues for each weekday is presented. Also presented are the standard deviations of the distributions of the individual days. The mean revenue figure decreases from Monday through Friday. However, given the size of the standard deviations, one could not readily conclude that there is a strong day-of-the-week effect.

**TABLE 1 Average and Standard Deviation of Revenue on Individual Weekdays ($)**

| Weekday | Average | Standard Deviation |
|---|---|---|
| Monday | 21,500 | 1,680 |
| Tuesday | 21,000 | 1,570 |
| Wednesday | 20,700 | 1,280 |
| Thursday | 20,700 | 1,470 |
| Friday | 20,500 | 1,480 |
| All weekdays | 20,900 | 1,530 |

In Figure 1 the distributions for all the paired differences, the DXY's, are shown. The average difference, D, may not be a large percentage of the average revenue figure of $20,900 given in Table 1. (It ranges from slightly more than 1 percent to more than 7 percent.) Yet all of the distributions are biased toward positive values, indicating that the ridership on the earlier day of the week is systematically greater than that on the later day. Note also that the distributions that are shifted the farthest to the right--for example, those of the differences between Monday and Friday, Monday and Thursday, or Tuesday and Friday--are those representing weekdays that are most separated in the week. The impression is that ridership (at least cash and ticket revenue) tends to decrease as the week progresses.

The sample means and standard deviations of these distributions are summarized in Table 2. The numbers

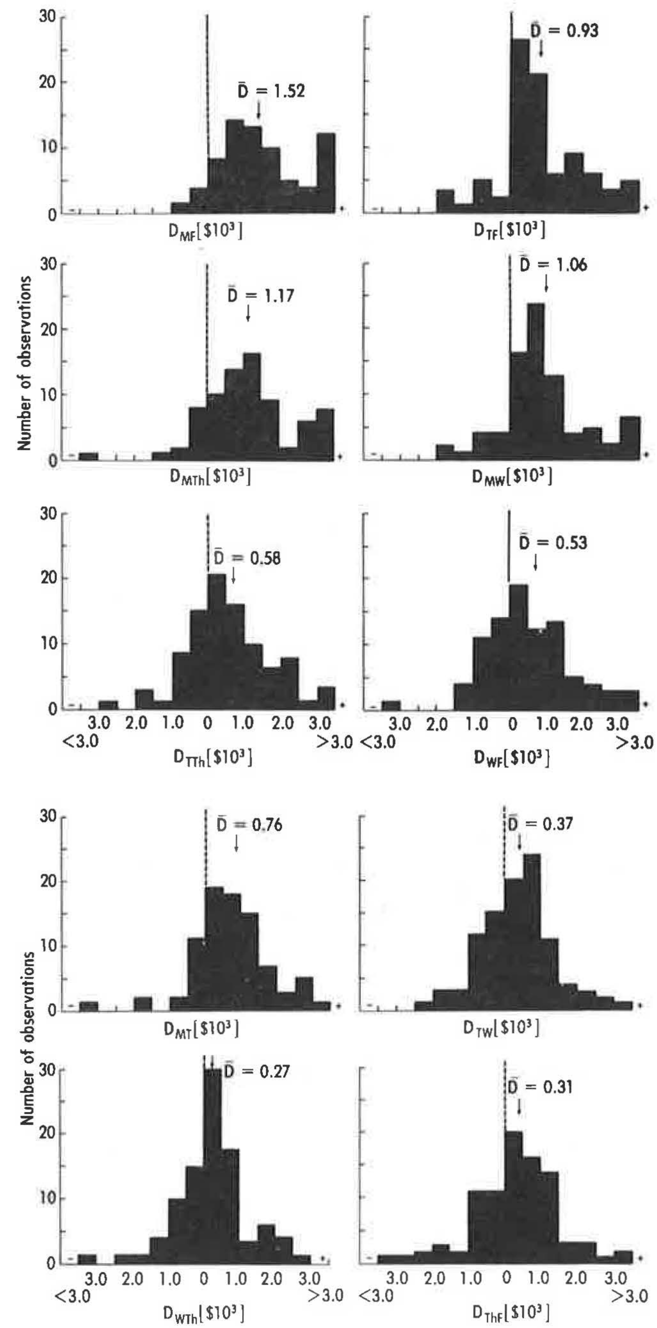


FIGURE 1 Distribution of revenue differences, D, between pairs of weekdays, X and Y, during same week and same month.

**TABLE 2 Statistics of Revenue Differences Between Pairs of Weekdays**

| Days Compared (XY) | No. of Days of Separation in Week | Average Difference DXY ($) | Standard Deviations of Differences ($) | No. of Observations | t-statistic |
|---|---|---|---|---|---|
| Monday-Friday | 4 | 1,520 | 1,400 | 71 | 9.15 |
| Monday-Thursday | 3 | 1,170 | 1,280 | 77 | 8.02 |
| Tuesday-Friday | 3 | 930 | 1,310 | 87 | 6.62 |
| Monday-Wednesday | 2 | 1,060 | 1,230 | 83 | 7.85 |
| Tuesday-Thursday | 2 | 580 | 1,170 | 93 | 4.78 |
| Wednesday-Friday | 2 | 530 | 1,220 | 89 | 4.10 |
| Monday-Tuesday | 1 | 760 | 1,060 | 84 | 6.57 |
| Tuesday-Wednesday | 1 | 370 | 1,040 | 99 | 3.54 |
| Wednesday-Thursday | 1 | 270 | 980 | 95 | 2.69 |
| Thursday-Friday | 1 | 310 | 1,220 | 92 | 2.44 |

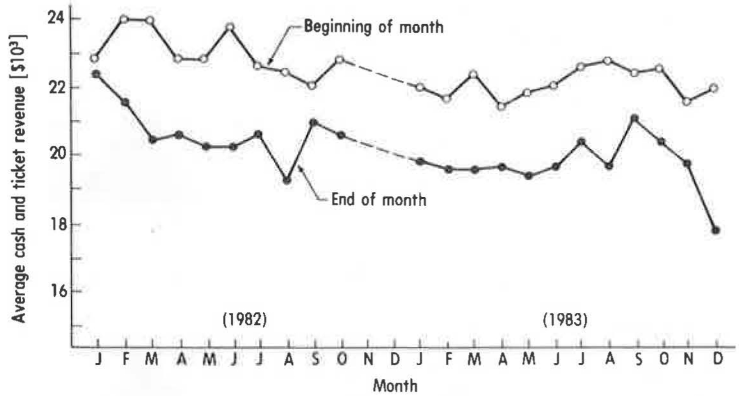


FIGURE 2 Revenue data for beginning and end of months.

of observations for each paired difference are also presented. The number of observations differs because the authors eliminated any pair involving a holiday and those pairs for which the 2 days constituting the pair were in different months.

A t-test on the paired differences implies that the hypothesis that the revenue data for any 2 different weekdays were generated from the same distribution should be rejected at the 0.01 level. (The calculated t-statistics are presented in Table 2.) It should be noted here that any seasonal variation (5) in ridership would tend to increase the variance in the paired differences, thereby making it more difficult to reject the hypothesis of a difference according to weekdays. Thus it can be observed that even a conservative test indicates significant differences in ridership among different weekdays during the same week.

## Part-of-the-Month Effect

In Figure 2, the time series of the revenue statistics for the beginning and end of each month are shown. (Data for the months of November and December 1982 are not used because of the influence of the drivers' strike.) The revenue at the beginning of the month is always higher than that at the end of the month. The graph in Figure 3 reinforces this image by portraying the distribution of the differences between the statistics representing the beginning and end of each month. The average difference of $2,350 is more than 11 percent of the average weekday total of $20,900 given in Table 1. The calculated t-statistic for this distribution is 12.55, which makes it possible to reject at the 0.0001 level the hypothesis that the revenue data at the beginning of each month and the data at the end of each month can be modeled as coming from the same distribution.

It should be noted that such a strong part-of-the-month effect could overwhelm the day-of-the-week effect observed previously. In Figure 4, a plot of the distribution of the differences between the revenues of all weekdays occurring during the same week yet during different months is shown. Once again, this difference was formed such that the revenue of the day that occurs later in the week (but earlier in its month) is subtracted from that which occurs earlier in the week (but later in its month). Unlike the distributions in Figure 1, this distribution has a strikingly negative bias, indicating that the part-of-the-month effect is overshadowing the day-of-the-week effect. (The only two positive values occurred for differences between

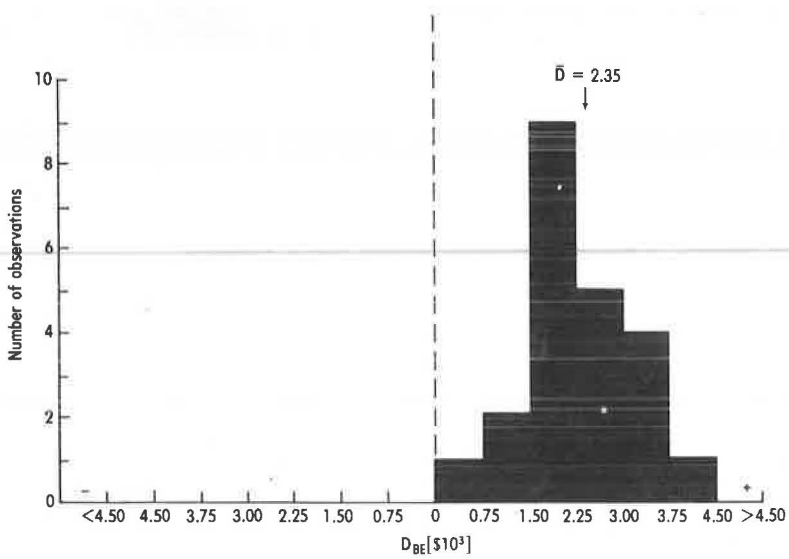


FIGURE 3 Distribution of revenue differences, D, between beginning, B, and end, E, of months.

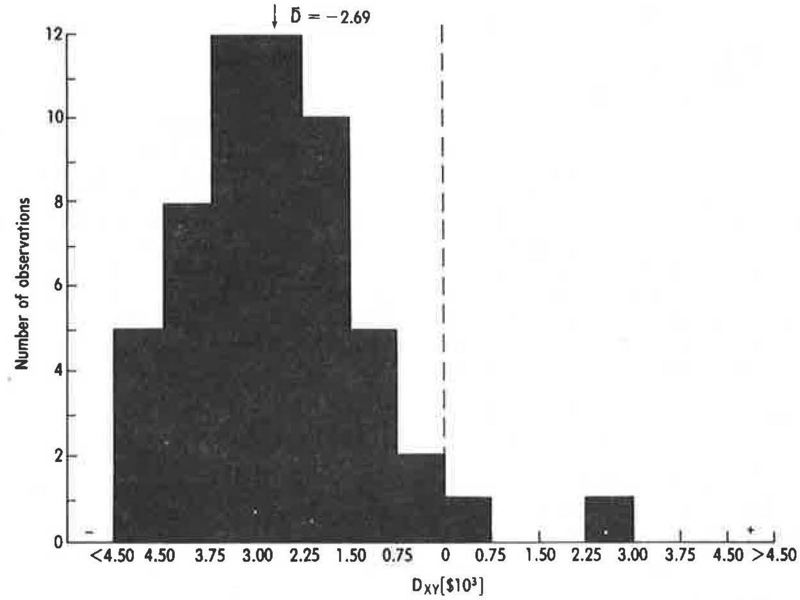


**FIGURE 4 Distribution of revenue differences, D, between pairs of weekdays, X and Y, during same week but different months.**

revenues for Monday-Friday pairs.) The average difference is almost 13 percent of the average weekday total given in Table 1.

## DISCUSSION OF POSSIBLE CAUSES OF TEMPORAL VARIABILITY OF BUS RIDERSHIP

No formal investigation of reasons for trip making was conducted. Nevertheless, it is tempting to speculate on the possible causes of the effects observed.

A possible reason for the part-of-the-month effect is the difference in disposable income between the beginning and end of a month, particularly among certain groups of riders. COTA schedulers remarked that they perceived ridership to be higher in the beginning of the month and believed that this increase was due to the distribution of entitlement checks at the beginning of each month; it was this remark that led the authors to investigate a part-of-the-month effect. Interestingly, a casual conversation with a local taxi driver revealed a similar perception: the driver said he did much better business at the beginning than at the end of the month because he carried more welfare recipients at the beginning of the month when they had just received their checks.

A technical reason contributing to the part-of-the-month effect could be related to the use of revenue data to indicate ridership. If many pass holders waited until the second week, or even late in the first week, of the month to purchase their passes, the cash and ticket revenue at the beginning of the month would be increased relative to that at the end of the month. However, the size of the difference between the beginning and end of the month is so large that it is unlikely that this alone could explain the results.

A decrease in the number of trips generated might also contribute to the day-of-the-week effect. If decreased disposable income does contribute to the decrease in trip making observed in the part-of-the-month effect, it could cause a decrease in trip making on a daily basis. That is, if disposable income continuously decreases from the beginning of a month to the end of a month for those making discretionary trips, it would also decrease continuously from the beginning to the end of each week, provided the entire week is contained in the same month.

It is also possible that personal business trips, such as trips to the bank or post office, are stored up on Saturday afternoon and Sunday, thereby yielding a higher potential for generating this type of trip at the beginning of the week. Some of these trips, the inventory of which is dissipated as the week progresses, will be made by transit. Finally, fewer work trips may be generated at the end of the week because of long weekends. Casual observation indicates that people are more likely to make long weekends by taking off Friday from work than Monday.

Diversion of trips from transit to automobile may also explain some of the day-of-the-week effect. The hypothesis here is that those individuals who frequently use transit for work trips, yet have an automobile available to them, will have a higher probability of choosing to use the automobile when their after-work activities deviate from the traditional pattern. After-work social activities appear to be more prevalent at the end of the week. Many stores remain open later at the end of the week. Individuals tend to leave work earlier on Fridays than on other days of the week. Individuals who might otherwise use transit to go to and from work may need an automobile to perform these after-work activities or may be unfamiliar with transit service other than that which they use for their routine commute.

### Implications of Results

It is emphasized that the reasons just given for the observed day-of-the-week and part-of-the-month effects are purely speculative; no formal investigation of the causes was conducted. However, whatever the reasons for the effects, they have important implications for transit planners. If the trends in variability were known, sampling resources could be used more efficiently by factoring in the variability rather than avoiding days that have been proposed to be variable--Mondays and Fridays, for example.

Likewise, sampling techniques for passenger counts, interviews, and surveys must be designed with this variability in mind. The authors' results cannot be interpreted to imply that ridership is always higher on Monday than on Tuesday, which is higher than on Wednesday, and so on. Indeed, several of the differences shown in Figure 1 are negative. However, the results do imply that unless a specific transit agency has found reasons to believe otherwise, it should expect systematic variability to exist, depending on the day of the week and on the part of the month. Not accounting for this variability in sampling strategy can lead to biased samples, which may in turn lead to misguided policy decisions, particularly if much of the variation occurs on low-volume routes the continued existence of which depends on sample results.

Agencies that estimate daily ridership based on monthly statistics may also wish to consider the variability witnessed here. It is currently assumed by COTA that the same fraction of monthly pass customers uses the transit services on any weekday and at any time of the month. Empirical evidence implies that this may not be the case.

Large fixed-schedule systems will probably not adjust daily or weekly schedules to account for variability. However, demand-responsive systems may wish to acknowledge such variability when planning the number of operators needed, or when determining a fleet size that balances overcapacity and undercapacity. This proposal would be contingent on the existence of such variability in the ridership for those forms of transit service. Given that the authors know of no study contradicting their results for any transit mode, they are led to believe that it is possible that systematic daily variability occurs in demand-responsive transit as well.

### Additional Work

The results of this study imply a broad research agenda. It would be interesting to know whether the daily trend observed in this study--that is, a decrease in transit patronage as the week progresses--is specific to the COTA system or if it is common to a number of urban systems with similar characteristics. It would be useful to be able to identify these characteristics. The transferability of the results could be investigated both through empirical studies of other transit agencies and through behavioral studies designed to identify the causes of the effects observed.

Furthermore, this study was conducted on a systemwide basis with data aggregated over the period of a day. Ridership surveys and counts are conducted at the route level and at a specific time. It would be useful to conduct a similar study on specific routes. This type of investigation would indicate whether all routes exhibit the same type of variability, and if not, the characteristics that would allow the type of variability to be exhibited on a specific route to be predicted. Conducting investigations at different times of the day would be useful in determining whether the variability occurs during both peak and off-peak periods. Because variation among disaggregate components is generally greater than that of the whole, larger variations than those noted in this paper would be expected to occur on individual routes and during specific time periods.

Time-of-day and seasonal effects in transit patronage are well accepted and easily explained. Evidence now exists that factors associated with the day of the week and the part of the month are also important.

## ACKNOWLEDGMENTS

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# Job Satisfaction and Transit Operator Recognition Programs: Results of a Survey of Muni Operators

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ABSTRACT

Described are the results of transit operator surveys that investigated operator perceptions of job conditions and potential enhancements to recognition programs. The surveys were carried out by the San Francisco Municipal Railway (Muni) as part of a demonstration project to improve transit service reliability and performance, funded by the Service and Methods Demonstration Program of UMTA, U.S. Department of Transportation. The project, which is currently still in progress, addresses recognition programs, attendance management, street supervision, rulebook revisions, and performance monitoring. A follow-up survey will be carried out as part of the project evaluation. The results of the initial survey have indicated that lack of recognition of good operators, poor public image of the transit system, and lack of responsiveness to operator suggestions are key sources of job dissatisfaction among operators. Operators favored several changes in the current Operator of the Month program, including increasing the number of operators recognized each month, rewarding more than one level of achievement, basing awards on the operator's overall record, and involving operators in the selection process. Type of award was not among the most important changes operators wished to see in the program.

As part of a federally sponsored demonstration project that focused on improving transit operator performance and service reliability, potential enhancements to the San Francisco Municipal Railway (Muni) recognition program for transit operators were examined. As a preliminary element of this investigation, a survey was conducted by Muni of its full-time and part-time operators. The purposes of the survey were to

1. Determine the operator's views on existing and proposed recognition program elements,
2. Assess the specific areas of job satisfaction and dissatisfaction, and
3. Provide a baseline for measuring effects of recognition and attendance program changes.

Specifically, the operators were asked to do five things:

1. Rate their jobs at Muni according to various characteristics,
2. Identify the best and worst aspects of their jobs,
3. Express their opinions on the Operator of the Month program and ways in which it could be improved,
4. Rank alternative types of awards for outstanding operators, and
5. Suggest ways to encourage good attendance.

After a pretest, the surveys were distributed in early April 1985 at all seven Muni divisions to all active (driving) operators, numbering slightly more than 2,000. A total of 243 responses, or about 12 percent, was obtained. Summarized in this paper are the results of the survey and its implications for design of a recognition program.

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## BACKGROUND

The objective of the demonstration project is to improve the reliability of service delivered to transit passengers by applying a variety of management and operational strategies. Among the primary strategies are an operator performance evaluation and motivation program, an attendance management program, and on-street supervision and control strategies.

The project was initiated in December 1983 with a review of Muni's current performance evaluation procedures and the approaches of several other transit authorities, including Metropolitan Dade Transit Administration, Houston Metro, Seattle Metro, Metropolitan Transit Commission of the Twin Cities (MTC), Flint Metropolitan Transit Authority, Chittenden County (Vermont), and San Diego Transit. In April 1984, representatives of Muni labor and management and representatives of the management of six other transit properties met to discuss approaches to establishing operator performance standards and motivation programs that could be used at Muni. (The six properties were selected to represent a variety of approaches; selection was based on recent innovations they had undertaken.)

The study group discussions focused on three major components of a performance standards and motivation program, as outlined in research by the Urban Institute (1): (a) measurement and targeting; (b) incentives, awards, and discipline; and (c) appraisal and communication.

Within these three categories, six aspects of performance were considered:

- Attendance and punctuality;
- Schedule adherence;
- Safety;
- Appearance and courtesy;
- Substance abuse and dealing with stress; and
- Observance of rules, operating procedures, and directives.

Specific measures were formulated by the study group and a series of recommendations was made (2). To date, several of the recommendations have been implemented, including the installation of a microcomputer-based operator performance tracking system (OPETS) developed for the project.

Recommendations included enhancing incentive, awards, and recognition programs to reward employees for their superior performance. Three distinct categories were discussed at the study group meeting:

1. Pay incentives--These are monetary payments (i.e., bonuses, incentive-based pay scales) directly tied to performance, which are a significant percentage of the total paycheck (i.e., 5 to 15 percent). Such pay incentives may be offered to individual employees or to groups (divisions) that meet the criteria.
2. Non-pay awards and recognition--These may be a small monetary award (less than $200), a nonmonetary gift (trip, dinner, trophy, etc.), preferential parking, dedicated bus with driver's name on it, or social activities. Publicizing the award (at ceremonies, in articles in newspapers) is also a form of recognition that enhances the impact of the award itself.
3. Time off--This is a unique type of nonmonetary reward that can be used to reward superior attendance and punctuality. Depending on its application, it can discourage the abuse of sick leave and transform a large number of expensive, unscheduled absences into a smaller number of less expensive, scheduled absences.

Nonpay awards and recognition were cited by the study group as offering the greatest return in terms of being both relatively inexpensive and a strong performance motivator. Although pay incentives were cited as being effective (in Flint and Houston), the increased data processing requirements and complication of pay structures might make them difficult for Muni to implement in the immediate future. More important, San Francisco City Charter laws prohibiting "giveaway of city funds" would present a greater barrier to pay incentives than to nonpay incentives. Thus, pay incentives should be considered only a longer term possibility. Although the law may also apply to monetary nonpay awards (i.e., cash prizes), the smaller magnitude and special nature of these awards might make them easier to structure in order to come within the law. Furthermore, because the cost is relatively low, it may be practical to establish special funds, perhaps raised by nontransit activities (advertising, business contributions); such funds would not be subject to the restriction. However, in the long run, it may be advisable to seek legal advice on how to remove the city restrictions.

In addition to the constraints just discussed, clear sentiment was expressed at the meeting by both management and labor that nonpay awards--in particular, publicized recognition--would be stronger motivators than pay incentives. This led the study group to recommend that Muni give a higher priority to nonpay incentives than to pay incentives for the immediate future.

Two philosophies were identified in designing an incentive-award system: the awards can be large and go to a few operators or be smaller and go to many. Rewarding a few results in focused recognition; positive examples are created. However, spreading the rewards spreads recognition, and makes rewards more attainable; this increased attainability is consistent with the philosophy of setting achievable (not necessarily easy) goals--success is a strong motivator.

MTC (Minneapolis-St. Paul) struck a compromise between these two philosophies in designing its incentive system. By using a two-tiered approach, several levels of achievement with increasing rewards were established. As many as 40 to 60 percent of operators qualified for the first level; a much smaller percentage reached the highest level. This appeared to be a good compromise and was recommended to Muni.

It was also suggested that Muni widen award distribution through the giving of separate awards for each division or mode. Alternatively, awards to an entire division can be used to create positive competition among divisions, and common spirit within divisions. This approach has been applied successfully in Houston.

Considerable discussion occurred at the study group meeting about which incentives are the strongest motivators; the recommendation was that this question be addressed to the employees themselves. Accordingly, a survey of operators was undertaken (as was done at MTC). The study group stressed the importance of follow-up and action based on the survey. Otherwise, expectations might be raised but not realized, which could adversely affect morale.

Another method for selecting the strongest motivators is to build some flexibility in the award programs, where it is practical to do so. For example, an operator might be offered a choice between a cash award and some time off.

Finally, in selecting operators for awards and recognition, selection criteria should be made clear in order to ensure credibility. These criteria should be tied in to the performance measurement system. Additional credibility can be achieved by involving operators in the selection process (an approach used at MTC).

From the start, the MTC recognition program was considered to be a good model for Muni. In addition, the undertaking of a survey at Muni was also based on MTC's experience. MTC's motivational research project, conducted in part by its Human Resources Department, involved a three-part survey effort: a written attitudinal survey of 320 randomly selected employees, focus group discussions involving 100 employees in total, and in-depth interviews of 38 employees by trained interviewers (3). The MTC effort was broader in scope and objective than that undertaken at Muni; at Muni the study group, involving union and management, had already considered several possible changes to the recognition program and was seeking additional operator input. Muni also intended to build on the experience of other transit properties, including MTC. As it turned out, the Muni survey results exhibited several similarities to those at MTC.

## EXISTING MUNI RECOGNITION PROGRAMS

Muni already had employee recognition programs in place when the project was undertaken. The Operations Department expends about $24,000 per year on recognition programs for operators and supervisors. About 80 percent of the funding for these programs is derived from outside sources such as the transit advertising contractor, film companies using Muni vehicles, the employee credit union, and the labor unions. For operators, such employee recognition programs include the Operator of the Month award and the Safety Award Program. The cost per operator in 1985 was $10. The Operator of the Month award program originally included a single operator being selected systemwide; this was modified to one operator per division being selected (Muni has seven divisions) in response to the study group's recommendation. The operator is selected based on passenger ballots and the division manager's review of the operator's record. The divisional operator of the month is given a plaque, an insignia sweater, a reserved parking space for one month, a night on the town, and an entry into the annual vacation prize drawing. The award is publicized in the Muni newsletter, which also was begun during the project period. Systemwide operators of the month also get a trophy and a $300 cash prize.

Safety awards are given to all operators who meet the safe driving record standards: no chargeable accidents for the year. About 70 percent of operators are recognized. Each receives a safe driver patch, belt buckle, and certificate. In addition, a banquet dinner is held for those who have completed 15 years or more as safe drivers.

## COMPOSITION OF THE SAMPLE

Before inferring conclusions from the survey responses, it is important to confirm the representativeness of the sample. This is particularly important because the response rate was only 12 percent. Unfortunately, it is difficult to test for representativeness as far as attitudinal bias is concerned because there were no comparative data. However, several key characteristics of Muni operators were examined: distribution of the responses over division, shifts, regular day off, work hours, and seniority. These characteristics were compared with actual statistics on the total Muni operator population to determine if the sample is representative.

The sample appears to adequately represent the distribution of operators among the divisions. With respect to the distribution of part-time versus full-time drivers, the sample appears to underrepresent the part-time drivers--the sample includes 6.8 percent part-time operators, whereas the actual percentage of part-time driving drivers (as of April 2) was 11.3 percent. Concerning shift, the sample was almost equally divided among day, night, and split shift--30.5 percent worked the day shift, 34.3 percent the night shift, and 35.2 percent split shifts. Comparative figures for the actual distribution of drivers by shift were not available. Concerning regular days off, the sample appears representative--41.7 percent reported having both weekend days, 40.9 percent neither weekend day off, and 17.45 percent one weekend day off, compared with actual figures of 41.3, 42.8, and 15.9 percent, respectively. The respondents included persons with a wide range of seniority levels ranging from relatively new hires to those with 34 years of service. There is some underrepresentation of drivers with low seniority.

For the purposes of this analysis of operator views, it is concluded that in general, the sample is sufficiently representative of Muni's operators in terms of seniority, shift, regular day off, division, and work hours. Again, concerning attitudinal bias, one cannot be confident; nevertheless, substantial negative opinions were expressed in the anonymous survey and in many cases the responses mirror those of the MTC experience.

## SURVEY RESULTS

In the following sections, the operators' views are presented on an aggregate basis; later the responses are stratified by several of the key characteristics discussed previously.

### Ratings of Muni

The operators were first asked to rate Muni on a number of different job characteristics. The rating scale categories were very good, good, neutral, poor, and very poor. Almost all of the operators indicated ratings for all of the 22 characteristics. Figure 1 shows a plot of the average rating for each characteristic (assigning values of +1 and -1 to the good and poor ratings, and +2 and -2 to the very good and very poor ratings, respectively). Note that the characteristic receiving the worst rating was by far responsiveness to operator suggestions, which, on average, placed close to the poor rating. Several characteristics received a rating that was on average about halfway between the neutral and poor rating, including planned social activities for operators, layover/recovery time, run time, Muni's community image, and recognition of good operators. The characteristic receiving the highest (best) ratings was quality of service provided to riders, followed by flexibility of policy for other time off, procedures for scheduling vacations, and fairness of attendance policy.

Looking at averages may mask some of the differences in the distribution of ratings. An alternative way to rank the results is to examine the percent of individuals rating the characteristic as very poor. The largest percentage of very poor ratings occurred for responsiveness to operator suggestions (32.5 percent) followed by planned social activities for employees (25.8 percent), Muni's community image (25.2 percent), running time (24.9 percent), recognition of good operators (24.0 percent), layover/recovery time (23.8 percent), communications between division management and operators (23.0 percent), variety of runs offered at sign-up (22.2 percent), and communication between street supervisors and operators (20.2 percent).

These results indicate that the primary sources of job dissatisfaction at Muni appear to derive from a lack of recognition of good operators by management and the public, lack of responsiveness to operator input, and frustration with the constraints imposed by the schedule. It is likely that the highest increases in job satisfaction would therefore derive from enhanced recognition programs, an aggressive program of publicity about the good aspects of Muni service and personnel, enhancement of camaraderie among the operators through social activities, opening up increased avenues of operator input through enhancements of the Joint Labor Management Board, and better communication with supervisors at the division and on the street, as well as attention to any real and substantial deficiencies in the schedule that may be a source of frustration among operators. The ratings also suggest that attendance policies are currently liberal enough to provide for employee needs.

### Best and Worst Aspects of Working at Muni

In addition to rating specific characteristics, operators were asked to identify (in an open-ended question) the best and worst aspects of their job at Muni.

The best aspects identified were, first, pay and benefits, identified by 49 percent of the operators, followed by public service and job security, identified by 15 and 14 percent, respectively.

The worst aspects identified were more diverse;

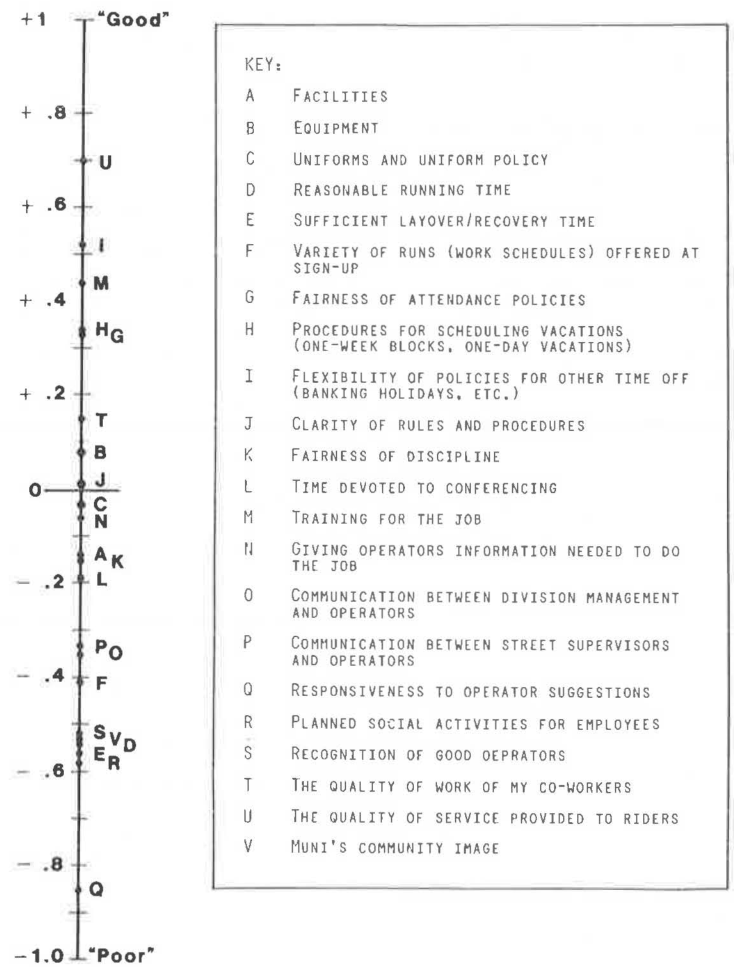


**FIGURE 1** Average ratings of Muni.

they included in order of prevalence poor management, insufficient schedules, stress on the job, bad equipment, uninformed public, and poor communication. Numerous operators made comments about the stress associated with their jobs and the need for opportunities to let off steam and relax. A number of operators commented on the additional stress caused by frequent changes in runs and schedules and some suggested fewer run sign ups per year.

Operator complaints about poor management and poor communication, combined with their extremely low ratings of responsiveness to operator suggestions, suggest that there are serious morale problems and that there is a need to provide some mechanism for operator feedback. One approach to this problem would be to initiate a recognition program for managers and supervisors; it could provide greater incentives to lower level management in order to improve communications with the operators and could include operator input. Several other approaches to improved communication were identified by the study group, for example, rap sessions and a newsletter (2).

## Opinions About the Current Operator of the Month Program

Operators were asked whether they thought they were likely to be selected Operator of the Month. The aim of this question was to determine whether the program was a meaningful motivator. Although 42 percent of the operators said they were likely to be operator of the month, the remainder indicated that they were not.

Muni's Operator of the Month program was instituted to recognize outstanding operators. A single operator was recognized systemwide and a ceremony was held at the operator's division. (Note that the Operator of the Month program was expanded in accordance with the Performance Study Group's recommendation to recognize one operator in each division each month. This change took place just after the survey was distributed and may have increased the number of operators who believe they are likely to be selected since the survey.) At the ceremony, cash awards, a trophy, and noncash prizes are presented. The winning operator also receives publicity in the Muni newsletter. The operator is selected based on recommendations of managers and through the opinions of passengers who may vote for an operator by turning in a card available on board Muni vehicles.

The concept of awarding a number of operators with outstanding performance each month through a modification of the Operator of the Month program was introduced in the survey. The majority of operators believed that awarding only 10 percent of operators would be the best motivator; they were presented with alternatives ranging from 10 to 90 percent.

Operators were asked to identify what they believed were the two most important improvements to the existing Operator of the Month program. They were presented with a series of alternative suggestions, including the following:

- Recognize more than one driver each month,
- Recognize more than one level of achievement,
- Make changes in the type of awards and prizes,
- Involve operators in the selection of winners,
- State selection criteria or formula,
- Base selection on overall record,
- Require minimum number of years of service,
- Give group (division) awards,
- Other

The responses indicated that about one-half of the operators believed that increasing the number of operators awarded each month was among the two most important alternatives, whereas about one-third cited awarding more than one level of achievement; almost as many believed that basing awards on the overall record and involving operators in the selection process were among the two most important alternatives. Note that changes in the type of awards ranked far less important; only about 7 percent of the operators listed it among the two most important program modifications. A surprising result was that stating the recognition criteria was only fifth in importance overall. Given the opportunity to make additional comments on the program, the majority of operators had no comments.

Opinions on Alternative Awards for Outstanding Performance

Operators were asked to rank several alternative types of awards for outstanding performance as their first, second, and third choices. In addition, they were given an opportunity to suggest additional awards not presented in the initial set of alternatives. The question was asked separately for three recognition programs, the individual Operator of the Month program, a proposed Division of the Month program, and the existing Safety Award Program. To analyze the results, the selections have been weighted to reflect their ranks as first, second, or third choice, and an average ranking has been calculated. (First choice was counted as 3 points, second choice as 2, and third choice as 1.) The results are shown in a plot in Figure 2.

Concerning the Operator of the Month awards, the highest average ranking was for paid time off. Gift certificates and award badges were close in second place. Recognition party and assigning the winning operator his/her own bus were less popular.

For the Safety Award Program, the results were fairly similar, with paid time off most popular, followed by awards or badges, then recognition party and assigned bus. It should also be noted that the operators preferred by more than 3 to 1 that the safety program remain separate from the Operator of the Month program. Note that the Operator of the Month program awards only a single operator (now one per division), whereas the safety award program awards a number of operators; the question was presented after identifying the possibility of a broader recognition program.

Concerning divisional awards, facility improvements were most popular; the remaining choices--trophies, social activities for the division, badges,

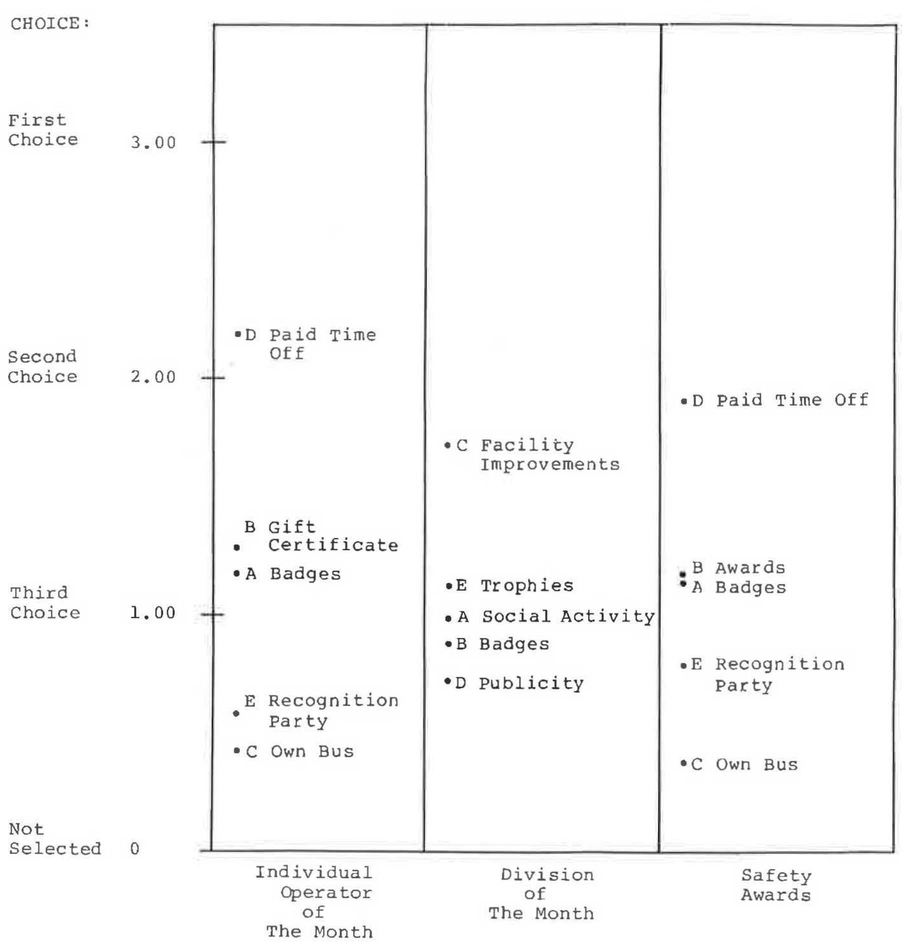


FIGURE 2 Average ranking of awards.

and publicity about the winning division--all were ranked fairly closely, in the order just given.

Operators had the opportunity to suggest additional awards. Although about two-thirds had no suggestions, 17 percent suggested cash awards and 8 percent suggested public recognition for the Operator of the Month program. Concerning divisional awards, 83 percent had no additional suggestions, and a few suggested social events, cash awards, and public recognition. In reviewing the responses to this question, it should be noted that the current time-off policies at Muni were rated highly by the operators. Therefore, although the operators ranked paid time off the highest, Muni might want to give serious consideration to less costly alternatives that ranked second overall, such as gift certificates, award ceremonies, and badges. Perhaps paid time off would best be saved as a reward for an excellent attendance record or an annual selection of one individual from the group of operators of the month.

In any event, it is clear that operators' first choices center on the most costly alternatives--paid time off and facility improvements. These are items that would require substantial resource commitments to the recognition program. Paid time off may be difficult given the City Charter restrictions on giveaway of public funds. Gift certificates using special funding sources may be more feasible (e.g., transit advertising, contributions). The other costly item, improvement to Muni facilities, should be justifiable within the City Charter restrictions.

It is also noteworthy that badges ranked fairly high in the set of choices for individual and safety awards. These low-cost items may buy a considerable amount of recognition for operators who responded with low ratings for Muni's public image and recognition of good operators. It is suggested that badges be included in the Operator of the Month program and that they be highly visible to the public, for example, perhaps cap badges should be given rather than belt buckles.

## Attendance Program

Operators were also asked how good attendance could best be encouraged. The variety of suggestions included the following: more money (15 percent), improved communications (15 percent), more layover (13 percent), more time off (10 percent), stricter discipline (9 percent), and better sign-up rules (5 percent).

In the author's opinion, more money in the form of increased pay would not increase attendance unless directly tied to attendance performance. Similarly, given the high ratings of time-off policies, the author believes that additional time off is unlikely to encourage better attendance; however, paid time off could be used to reward operators with particularly good attendance. It is also interesting to note that the number of operators identifying improved communication was the same as the number identifying more money. Perhaps low-cost communication efforts would have some beneficial effect on attendance. Overall, there does not appear to be a clear consensus among operators on the best way to motivate them to reduce absenteeism. Thus, the author believes that attendance program suggestions might best be derived from the experience of other transit properties.

It should also be noted that sentiments expressed by several operators indicated their desire for stricter discipline of those operators who abuse attendance policies while recognizing and rewarding the majority of good operators. Comments included, for example, "do something about operators who abuse sick time," "it's too easy to take time off," "get rid of bad operators," and "don't make good drivers suffer with bad drivers on Muni policies."

## Stratification of Responses by Key Operator Characteristics

As an additional aid in the design of an effective recognition program, the survey responses are disaggregated in the following sections by division, seniority, shift, regular day off, and perceived likelihood of being Operator of the Month.

### Differences by Division

The operators' ratings of service characteristics were examined on a divisional basis. Some divisions indicated great satisfaction with one characteristic but great dissatisfaction with another. Statistics indicated that the most significant differences among divisions occurred with respect to time for conferencing, equipment, and communications between division management and operators. Significant differences were also found regarding layover time, run time, uniforms and uniform policy, facilities, and fairness of discipline. It should be noted that correlations were evident between division and other key characteristics--seniority and part-time or full-time status.

### Differences by Seniority

Operators were disaggregated into four seniority categories: less than 5 years, 5 to 9 years, 10 to 19 years, and 20 years or more. Several significant differences among seniority categories were found; these were in the ratings of Muni for uniform and uniform policy, layover time, variety of runs offered, training for the job, giving operators sufficient information for the job, responsiveness to operator suggestions, and Muni's image in the community.

In general, the differences among seniority categories indicated that the operators with the least seniority and, in some cases, those with the greatest seniority were more satisfied with their jobs. For example, 31 percent of those with less than 5 years at Muni rated uniforms and uniform policy poor or very poor, compared with 51 percent of those with 10 to 19 years at Muni. Similarly, 44 percent rated responsiveness to operator suggestions as poor or very poor compared with 72, 74, and 60 percent of the other groups with increasing seniority. Concerning Muni's community image, the most senior operators were the least critical--33 percent rated the image as poor or very poor followed by 43 percent of those with less than 5 years; this was in contrast with 67 and 62 percent in the 5 to 9 and 10 to 19 year groups, respectively.

Ratings of layover time adequacy revealed that the most senior operators were most satisfied, whereas the lower seniority operators--particularly the 5 to 9 year group--were least satisfied. This may be partially explained by the sign-up procedures, which allow the best runs to be selected by the operators with the greatest seniority. However, concerning the variety of runs offered at sign up, the operators with the least seniority were the most satisfied; 28 percent of those with less than 5 years of seniority rated the variety of runs poor or very poor compared with 60, 54, and 59 percent of those groups with increasing seniority.

Finally, concerning training and information provided for operators to do their job, operators with less than 5 years of seniority were the most satisfied.

Comparing average ratings based on numerical scaling of the responses indicates that the groups with less seniority view three job characteristics with similar levels of dissatisfaction: layover, variety of runs, and responsiveness to operator suggestions, whereas the higher seniority groups do not. Also, the groups with middle seniority view the community image much more negatively than the extreme groups--those with less than 5 years and those with 20 year or more seniority.

As noted previously, a correlation existed between seniority and division. Nevertheless, it appears that neither seniority nor division fully explains the effects of the other. For example, it appears that the least satisfied operators are those in the middle range of seniority and are concentrated at three particular divisions. The divisions with the highest percentage of operators in the middle range of seniority overlap but do not coincide with these three divisions. However, at the same time the division noted as containing the most satisfied operators (based on the ratings) has the smallest percentage of operators in the middle seniority range.

### Differences by Shift

For the most part, shift did not influence survey responses. Some differences were noted in the percentages ranking particular awards as their first, second, and third choices. Split-shift operators tended to rank paid time off higher than did others. Day shift operators tended to rank recognition parties higher and facility improvements lower than those working other shifts. These differences are minor and should not necessarily influence the choice of awards in a recognition program. First-choice selections were the same across shifts.

### Differences by Regular Day Off

To examine the effect of regular day off, operators were disaggregated into three groups: persons having both weekend days off, those having one weekend day off, and those having no weekend days off. However, this characteristic appeared to have only minor influences on the responses.

### Characteristics of Those Who Did Not Consider Themselves Likely To Be Selected Operator of the Month

The operators who indicated they were not likely to be selected as Operator of the Month tended to have negative views of Muni in terms of the following characteristics:

- Equipment,
- Uniforms and uniform policy,
- Layover time,
- Variety of runs offered,
- Clarity of rules,
- Fairness of discipline,
- Informing operators, and
- Responsiveness to operator suggestions.

Thus, job dissatisfaction appears to correlate with the employee's investment in the recognition programs. Overall, operators who did not think they would be selected rated Muni more negatively than did operators who thought they would be selected.

Other differences (between those who believed they were likely to be selected and those who believed they were not) were (a) part-time versus full-time status and (b) regular day off. Those operators who worked part time and those who had neither weekend day off were more likely than others to believe they would be selected Operator of the Month.

It is particularly interesting to examine the Operator of the Month program improvements that are most important to those who thought they were unlikely to be selected. In general, they ranked the suggested improvements similar to other operators, although a higher percentage responded to the question. The improvements they appeared to be much more likely to choose were (a) involve operators in the selection process, and (b) reward more than one level of achievement. These changes should be most likely to increase the impact of the recognition program.

## SUMMARY OF SURVEY RESULTS

1. Primary sources of job dissatisfaction at Muni are a lack of recognition of the good operators by both management and the public, lack of responsiveness to operator input, and, for many operators, frustration with the scheduled run and recovery time.
2. Some divisions exhibited greater operator dissatisfaction than others in the areas related to (a) communication with management and (b) facilities.
3. Operators in the middle levels of seniority (5 to 19 years) were more dissatisfied with a number of job characteristics than were those with either high or low seniority.
4. Flexibility in time-off policies, fairness of the attendance policy, and procedures for scheduling vacations were all rated high.
5. Approximately 4 of every 10 operators believed that they were likely to be selected Operator of the Month. Operators favored several changes in the program, most important, increasing the number of operators rewarded each month and rewarding more than one level of achievement; these changes were followed by basing awards on the overall record and involving the operators in the selection process. Those operators who did not believe they were likely to be selected believed that the most important changes to the program were involvement of operators in the selection process and rewarding more than one achievement level. Note that operators identified 10 percent as the appropriate number of operators to be awarded in order to make the program a good performance motivator.
6. Type of award was not among the most important changes, but was addressed in the surveys. Operators favored paid time off over other awards to individuals and facility improvements for awards to divisions. They also preferred keeping the Safety Award Program as a separate program.

## RECOMMENDATIONS

Based upon the survey results, it is recommended that the following seven steps be undertaken to improve recognition programs:

1. Create a joint labor management committee to revise the Operator of the Month program.
2. Prepare a set of recognition criteria and use the microcomputer monitoring system in the selection process.
3. Identify a second level of achievement for awards.
4. Develop a Division Award Program that will reward a division with funds to improve amenities in the division. This may be effective as a group motivator and may permit the expenditure of Muni funds for recognition more easily than will individual awards, which face City Charter restrictions.
5. Increase publicity about the achievements of Muni's operators, create visibility for the recogni-

tion program, and inform operators about efforts to improve the public image of Muni.

6. Target problem divisions for a program of increased conferencing and communications with operators.

7. Create a Manager Recognition Program to reward managers who excel and include operator input in selecting outstanding managers.

## CONCLUSION

As of this writing, this project is still in progress. The union is currently reviewing survey results and will shortly confer with management on management's response to the survey. Muni management has had a favorable reaction to many of the recommendations.

The author believes that the survey was useful in pinpointing problems and solutions and should be useful in providing greater credibility with Muni drivers. However, the making of definitive conclusions on the effectiveness of the process must follow implementation of recognition program changes.

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The views expressed in this paper are not necessarily those of the sponsoring agencies.

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# Bus Marketing Costs: The Experience of 18 Section 15 Reporters from 1981 to 1983

ROSEMARY BOOTH

ABSTRACT

The costs incurred by 18 transit agencies from 1981 to 1983 to market their bus services are reported. These costs are based on financial and operating data reported to the federal government under Section 15 of the Urban Mass Transportation Act of 1964, as amended. The operators whose reports were examined are among the largest agencies, and carry about one-half of the passenger trips reported by bus operators under Section 15. Total marketing expenditures in 1983 for the 18 agencies reporting were nearly $33 million. The average agency spent more than $1.8 million on marketing, or about 2.4 percent of operating costs, less than that spent by two other service firms examined. Marketing and operating costs both kept pace with inflation during the time period. On average, the 18 agencies spend $0.031 per passenger trip and $0.007 per passenger mile on marketing in 1983; marketing costs per passenger appeared to decline as fleet size and market share increased. The average agency spent more than 50 percent of its marketing budget on customer services in 1983. The remainder of the budget was spent on promotion (29 percent), planning (14 percent), and market research (5 percent). Costs in all of the marketing activity areas varied considerably among agencies and within agencies over time. It is suggested that transit agencies have not yet adopted a marketing orientation to managing their services and that a larger data set, more reliable ridership data, and more refined measures of service area population would improve analysis of the effectiveness of marketing expenditures.

Marketing is a critical activity in the management of transit services because it is the only strategy area with a direct impact on consumer demand (1). With the decline of federal operating subsidies, the role of marketing assumes additional importance. Although many transit agencies acknowledge the key role marketing should play, few have yet adopted a marketing approach to managing their services. Evidence of this gap between theory and practice can be found by examining actual marketing expenditures in the industry.

## SECTION 15 DATA SOURCE

Described is what 18 publicly owned transit agencies spent to market their bus services from 1981 to 1983, both total expenditures as well as expenditures for particular types of marketing activities. One purpose of the study is to provide information that transit agencies can use as benchmarks for comparing their marketing costs with those of similar operators. The analysis serves strictly as a guideline in this regard; the related and important issue of marketing effectiveness (or productivity) is not addressed.

The analysis is based on data reported to UMTA, U.S. Department of Transportation, under Section 15 of the Urban Mass Transportation (UMT) Act of 1964, as amended. This act currently provides for the collection of financial and operating information from all transit operators receiving federal assistance under Sections 5 or 9 of the UMT Act.

Operators are required to report financial information in four functional categories: vehicle operations, vehicle maintenance, nonvehicle maintenance, and general administration. UMTA publishes these required data in its annual Section 15 report. Some agencies choose to report additional details about their operations, and these agencies file Level C, B, or A reports, in order of increasing detail. About two dozen agencies filed Level A reports from 1981 to 1983.

Both published data (2-4) and unpublished Level A information were used for this analysis. The published data included operating expense, revenue, ridership, and service information. The Level A data consisted of expenditures in four reporting categories: customer services, promotion, market research, and planning. The sum of costs in these categories is equivalent to the category "marketing expenditures" reported under Level B. [See Figure 1 for a diagram of Section 15 expense classifications at the various reporting levels (5).]

## SELECTION OF DATA SET

The time frame of 1981 to 1983 was selected, yielding 3 years of data. Although Section 15 reports have been filed since 1979, data quality improved markedly from 1981 on, leading to the selection of that year for the beginning of the analysis. Reports filed for 1983 were the most recent available and hence define the end year of the study. (Data for 1984 were incomplete at the time of publication; limited analysis of these 1984 data suggests that their inclusion would not materially change the conclusions of the study.) Data from 1981 and 1982 pertain to fiscal years. Data from 1983 denote calendar-year information because of a change in Section 15 reporting

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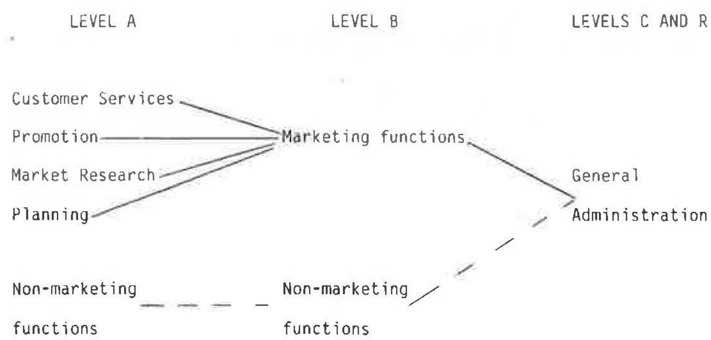


**FIGURE 1 Section 15 expense classifications at various reporting levels.**

requirements. All expenditures are given in actual (not constant) dollars, as reported, except where noted otherwise.

Operators were selected to include all those who filed Level A reports from 1981 to 1983 and had expenditures in at least one marketing category for all 3 years. The analysis was limited to one mode in order to control for differences in operating costs and other characteristics between modes. Motor bus service was selected because a substantial majority of the agencies reporting Level A data are motor bus operators, reflecting the predominant mode for operators nationwide. Described are marketing expenditures as they were reported by all-bus systems as well as for the motor bus operations of multimode agencies.

A total of 19 transit agencies fit the criteria just given. One of these was eliminated because it was substantially smaller than the next largest agency, leaving a total of 18 agencies for examination. Ten of the agencies are all-bus operations. A list of the 18 agencies and their operating characteristics is given in Table 1. An additional restriction was imposed on the data set, in terms of directly operated versus purchased service, with purchased service excluded to make the agencies more comparable. It was not possible to distinguish between directly operated and purchased service in Section 15 data before 1983; however, most purchased service involved commuter rail and/or demand-response modes, both of which were omitted from the analysis. In 1983 Section 15 data began to separate direct response from purchased service by mode and this purchased service was omitted from the current study. In all cases, purchased bus service was negligible.

## DESCRIPTION OF PROPERTIES

The 18 agencies comprise roughly 5 percent of all motor bus operators reporting Section 15 data (at all levels) during the years 1981 to 1983. These 18 agencies are not representative of all U.S. motor bus systems, or even of the Section 15 motor bus operators--they are biased toward the largest 12 percent, that is, agencies operating 250 or more vehicles. Figure 2 shows a comparison of all Section 15 motor bus reporters with the 18 properties whose data are used for this analysis, on the basis of fleet size. Because system size is related to service area population, it follows that the operating characteristics and marketing behavior described here are more comparable to those of motor bus operators in large cities than to those in medium- and small-sized urban or rural areas.

Figure 3 shows the share of all Section 15 motorbus operating characteristics accounted for by the 18 agencies. The 18 operators carry one-half of all U.S. motor bus passengers, but account for only 40 percent of the total passenger miles. The disparity

**TABLE 1 1983 Bus Operating Data for 18 Agencies**

| Transit System | No. of Revenue Vehicles | Operating Expense ($000s) | Fare Revenue ($000s) | No. of Passenger Trips (000s) | No. of Passenger Miles (000s) |
|---|---|---|---|---|---|
| Orange County Transit District (TD), Santa Ana, Calif. | 526 | 64,367 | 14,011 | 27,657 | 202,308 |
| Metropolitan Transit Commission (MTC), Minneapolis, Minn. | 1,046 | 88,364 | 30,958 | 75,341 | 235,455 |
| Via Metropolitan Transit (VIA), San Antonio, Tex. | 456 | 30,685 | 8,368 | 33,433 | 148,245 |
| New York City Transit Authority (CTA), N.Y.[a] | 4,573 | 664,945 | NA | 1,062,142 | 2,027,245 |
| Santa Clara County Transportation Authority (TA), San Jose, Calif. | 758 | 85,794 | 8,553 | 36,945 | 149,267 |
| Southeastern Pennsylvania Transportation Authority (SEPTA), Philadelphia, Pa.[a] | 1,455 | 153,616 | NA | 186,467 | 516,848 |
| Southeastern Michigan Transportation Authority (SEMTA), Detroit, Mich.[a] | 1,249 | 138,459 | NA | 143,205 | 430,863 |
| Chicago Transit Authority (TA), Ill.[a] | 2,295 | 339,276 | NA | 473,986 | 1,101,696 |
| Port Authority of Allegheny County (PATCO), Pittsburgh, Pa.[a] | 1,034 | 110,250 | NA | 83,545 | 426,717 |
| Municipality of Metropolitan Seattle (METRO), Wash.[a] | 1,195 | 93,090 | NA | 60,564 | 385,023 |
| Massachusetts Bay Transportation Authority (MBTA), Boston, Mass.[a] | 1,157 | 105,770 | NA | 98,695 | 211,544 |
| Metropolitan Atlanta Rapid Transit Authority (MARTA), Ga.[a] | 1,023 | 77,721 | NA | 84,936 | 348,238 |
| Southwestern Ohio Regional Transit Authority (SORTA), Cincinnati, Ohio | 390 | 36,893 | 11,338 | 36,735 | 145,981 |
| San Diego Transit Corporation (TC), Calif. | 340 | 32,647 | 12,400 | 26,490 | 136,335 |
| Bi-State Transit System, St. Louis, Mo. | 890 | 80,235 | 22,943 | 56,544 | 200,710 |
| Regional Transportation District (RTD), Denver, Colo. | 776 | 76,351 | 17,960 | 48,250 | 250,066 |
| Alameda-Contra Costa County Transit, Calif. | 901 | 96,415 | 32,331 | 75,450 | 457,982 |
| Dallas Transit System (TS), Tex. | 636 | 41,048 | 19,831 | 37,271 | 177,769 |
| Total | 20,700 | 2,315,926 | 178,693 | 2,647,656 | 7,552,292 |
| Average | 1,150 | 128,663 | 17,869 | 147,092 | 419,572 |

[a]Property operates additional modes other than demand-response transit.

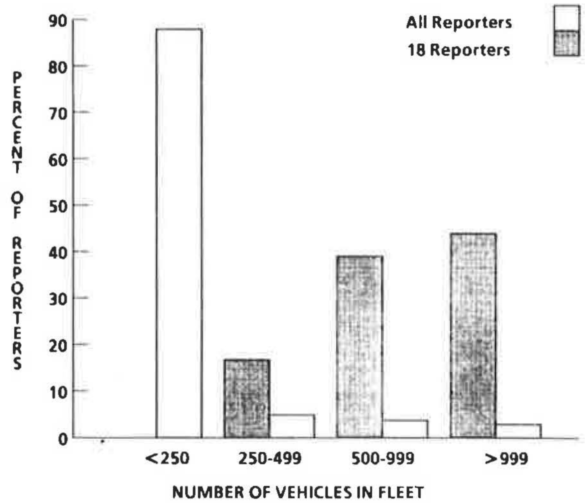


FIGURE 2 Distribution of 18 agencies and all Section 15 reporters by fleet size (1983).

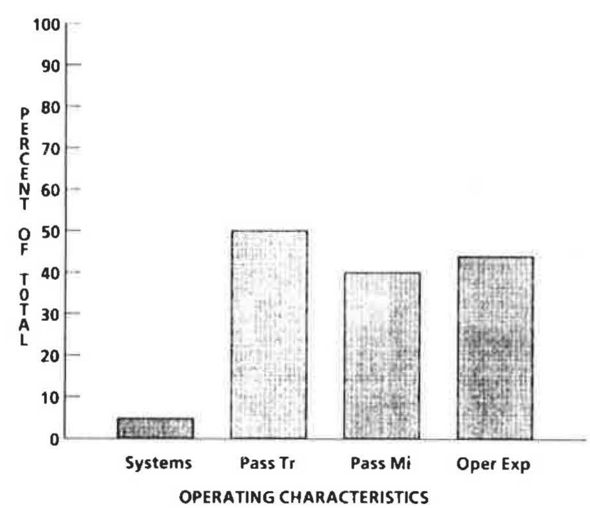


FIGURE 3 Share of all Section 15 bus operating characteristics accounted for by 18 agencies.

reflects the shorter trip lengths in many of the urban areas where the 18 agencies operate. The 18 reporting agencies accounted for 44 percent of all motor bus operating expenses, suggesting that they are more efficient than average, where efficiency is defined as cost per passenger.

## TOTAL MARKETING COSTS

In 1983, the 18 motor bus agencies spent a total of nearly $33 million on marketing activities, or an average of more than $1.8 million per agency, as indicated by the data in Table 2. To compare agencies of different sizes, marketing expenditures were calculated in relation to operating expenses, operating revenue (fares), passenger trips, and passenger miles. The primary measure used was marketing costs in relation to operating expenses because operating expenses are more consistently defined and reliably reported than the other variables.

## 1983 MARKETING COST RATIOS

Marketing expenditures ranged between 0.2 and 4.8 percent of total operating expenses, and amounted to 2.2 percent of operating expenses on average. This amount is lower than the norm for other service industries, including transportation services. American Telephone and Telegraph, for example, spent more than 13 percent of operating expenses on marketing in 1983, according to their 1983 Annual Report. Delta Airlines, as indicated by the data in Table 3, spent more than 12 percent of operating expenses on marketing in the same year, according to their 1984 Annual Report. Transit agencies in New York, Chicago, Boston, Atlanta, and Philadelphia (in that order) spent the lowest percentages of operating expenses on marketing.

Marketing expenditures among the 18 agencies amounted to an average of $0.031 per passenger in 1983, ranging between $0.001 and $0.101 per passenger. Again, agencies in New York, Chicago, Atlanta, Philadelphia, and Boston spent the least on a per-passenger basis. This is reasonable, if marketing costs are expected to decline with market share. For example, all of these agencies except that in Boston carry more passengers per standard metropolitan statistical area population than average.

TABLE 2 1983 Bus Marketing Expenditures for 18 Agencies

| Transit System | Total Marketing Expenditure | Marketing Operating Expense | Marketing Fare Revenue | Marketing Passenger Trip | Marketing Passenger Mile |
|---|---|---|---|---|---|
| Orange County TD | 1,626,649 | 0.025 | 0.116 | 0.059 | 0.008 |
| Minneapolis MTC | 2,357,932 | 0.027 | 0.076 | 0.031 | 0.010 |
| San Antonio–VIA | 1,469,491 | 0.048 | 0.176 | 0.044 | 0.010 |
| New York CTA | 1,557,805 | 0.002 | NA | 0.001 | 0.001 |
| Santa Clara County TA | 3,720,934 | 0.043 | 0.435 | 0.101 | 0.025 |
| Philadelphia–SEPTA | 1,350,022 | 0.009 | NA | 0.007 | 0.003 |
| Detroit–SEMTA | 2,983,519 | 0.022 | NA | 0.021 | 0.007 |
| Chicago TA | 1,663,083 | 0.005 | NA | 0.004 | 0.002 |
| Pittsburgh–PATCO | 1,625,366 | 0.015 | NA | 0.019 | 0.004 |
| Seattle METRO | 3,385,143 | 0.036 | NA | 0.056 | 0.009 |
| Boston–MBTA | 787,675 | 0.007 | NA | 0.008 | 0.004 |
| Atlanta–MARTA | 583,094 | 0.008 | NA | 0.007 | 0.002 |
| Cincinnati–SORTA | 1,451,348 | 0.039 | 0.128 | 0.040 | 0.010 |
| San Diego TC | 1,275,260 | 0.039 | 0.103 | 0.048 | 0.009 |
| St. Louis–Bi-State | 2,033,750 | 0.025 | 0.089 | 0.036 | 0.010 |
| Denver–RTD | 1,917,311 | 0.025 | 0.107 | 0.040 | 0.008 |
| Alameda-Contra Costa | 2,007,455 | 0.021 | 0.062 | 0.027 | 0.004 |
| Dallas TS | 1,200,992 | 0.029 | 0.061 | 0.032 | 0.007 |
| Total | 32,996,829 | | | | |
| Average | 1,833,157 | 0.024 | 0.135 | 0.032 | 0.007 |

Note: Acronyms for the transit systems are defined in Table 1. Values in the table are in dollars.

TABLE 3 Comparison of Expenditure Rates

| | 18 Bus Reporters (1983) | Greyhound (1983) | Trailways (1984) | Delta Air Lines (1983) |
|---|---|---|---|---|
| Marketing/operating expense | 0.024 | – | – | 0.123 |
| Marketing/passenger trip | 0.032 | – | – | 13.170 |
| Marketing/passenger mile | 0.007 | – | – | 0.018 |
| Promotion[a]/operating expense | 0.007 | 0.044 | 0.024 | 0.017 |
| Promotion[a]/passenger trip | 0.0091 | 0.647 | 0.513 | 1.830 |
| Promotion[a]/passenger mile | 0.002 | 0.0041[b] | 0.0025[b] | 0.0025 |

[a]Defined as advertising or promotion.
[b]Estimate.

Regression analysis of the 1983 data confirmed that the ratio of marketing costs to operating expenses was inversely related to fleet size and (somewhat less certainly) to market share. Market share was defined as the ratio of passenger trips to urbanized area population. (Results of the regression analysis can be obtained from the author.) Other studies have found both positive (6) and negative (7,8) correlations between marketing costs and market share.

Marketing expenditures per passenger mile ranged from $0.001 to $0.025, with most agencies spending between $0.002 and $0.013. Delta Airlines, on the other hand, spent $0.018 per passenger mile on marketing in 1983 (Table 3). Santa Clara County was the only transit agency to reach or exceed this ratio. It could be argued that transit services should show higher marketing expenditures than air travel services on a passenger-mile basis because the transit passenger trips are substantially shorter.

Because fare revenue was not reported by mode from 1981 to 1983, the ratio of marketing to fares could only be reliably determined for the 10 single-mode systems in the analysis. For these 10, marketing amounted to an average 13.5 percent of fare revenue in 1983, with a range of from 6 to 13 percent for most of the systems (Table 2). However, the ratio of marketing costs to fares can be misleading. For one thing, some agencies apparently spending at the high end of the scale simply have low fare-recovery ratios. At the same time, a low fare-recovery ratio does not necessarily mean poor market support for transit because some agencies recover a substantial portion of operating costs through a dedicated local tax, which could be considered another measure of local support for transit (or sales response to the system). In San Diego, for example, marketing costs amount to 43.5 percent of fares because fares (and the fare-recovery ratio) are very low; at the same time, the city dedicates tax revenues to transit, making the fare-recovery ratio a poor indicator of local support.

## FROM TRENDS 1981 TO 1983

Two distinct trends for the 18 agencies as a whole can be observed from 1981 to 1983: revenue and costs increased, while ridership declined; these trends are shown in Figure 4. (Note that in the figure fare revenue reflects 10 all-bus systems only.) Both total operating expenses and marketing expenses were 9 percent higher in 1983 than in 1981. Taking into account the effects of inflation, expenditures and revenue decreased slightly from 1981 to 1983. At the

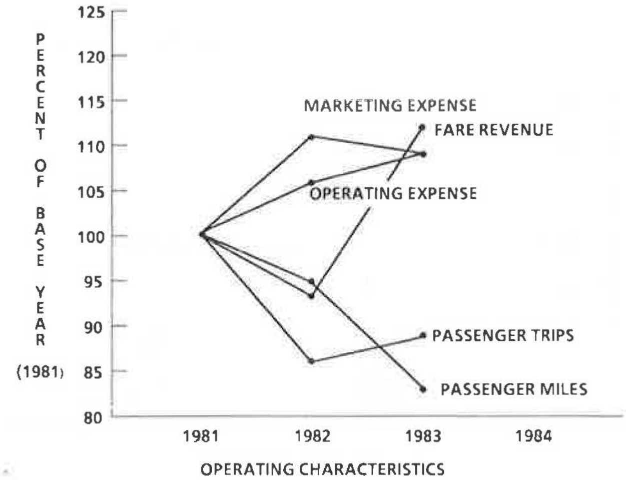


FIGURE 4 Bus operating trends for 18 agencies (1981-1983).

same time, the number of passenger trips decreased by 11 percent, possibly in response to higher fares and stable gasoline prices. (In real terms, fares declined, but gasoline prices declined even more over the 2-year period.) The number of passenger miles declined by 17 percent from 1981 to 1983, reflecting cuts in service as well as decreased ridership.

The average percentage increase in marketing expenditures was about 14 percent over the time period, as indicated by the data in Table 4. This figure is higher than the 9 percent change in overall marketing costs because it reflects relatively higher percentage increases at some of the smaller sized agencies, which are equally weighted in calculating the average. The average also masks considerable variation among agencies. From 1981 to 1983, marketing expenditures declined for seven agencies, and increased by 35 percent or more (in actual dollars) at six others.

The average percentage change in the ratio of marketing expenditures to operating expenses from 1981 to 1983 was 1 percent (Table 4). The increase was particularly notable from 1981 to 1982, when marketing expenditures as a whole increased by 11

TABLE 4 Change in Bus Marketing Expenditures (1981-1983)

| Transit System | Total Marketing Expenditure | Marketing/ Operating Expense | Marketing/ Passenger Trips | Marketing/ Passenger Miles |
|---|---|---|---|---|
| Orange County TD | -0.12 | -0.34 | -0.11 | -0.15 |
| Minneapolis MTC | -0.14 | -0.28 | 0.04 | 0.00 |
| San Antonio–VIA | 0.42 | 0.10 | 0.37 | -0.12 |
| New York CTA | 0.10 | 0.05 | 0.23 | 0.51 |
| Santa Clara County TA | 0.35 | 0.14 | 0.27 | 0.31 |
| Philadelphia–SEPTA | 0.05 | -0.17 | 0.34 | 0.27 |
| Detroit–SEMTA | -0.03 | -0.10 | -0.39 | 0.08 |
| Chicago TA | 0.19 | 0.18 | 0.35 | 0.33 |
| Pittsburgh–PATCO | 0.18 | 0.03 | 0.39 | 0.15 |
| Seattle METRO | 0.70 | 0.46 | 1.09 | 1.30 |
| Boston–MBTA | 0.03 | -0.01 | 0.23 | 0.22 |
| Atlanta–MARTA | -0.37 | -0.39 | -0.18 | -0.26 |
| Cincinnati–SORTA | 0.87 | 0.64 | 0.96 | 1.26 |
| San Diego TC | 0.60 | 0.66 | 1.34 | 1.18 |
| St. Louis–Bi-State | -0.20 | -0.15 | 0.01 | 0.08 |
| Denver–RTD | -0.30 | -0.38 | -0.21 | -0.23 |
| Alameda-Contra Costa | -0.12 | -0.23 | 0.27 | -0.10 |
| Dallas TS | 0.37 | -0.04 | 0.39 | 1.00 |
| Average | 0.14 | 0.01 | 0.30 | 0.32 |

Note: Acronyms for transit systems are defined in Table 1. Values in the table are in dollars.

percent while operating expenses increased by only 6 percent, as shown in Figure 4. Again, there is substantial variation from one site to another. Although marketing obtained a much higher share of the operating budget at three agencies--Seattle (+46 percent), Cincinnati (+64 percent), and San Diego (+6 percent)--from 1981 to 1983, its share actually declined in relation to the total operating budget at 10 other agencies and indicated little change at the remaining 5 agencies.

Marketing expenditures per passenger trip increased during the 1981-to-1983 period by an average 30 percent in actual dollars (Table 4), or by about 16 percent after adjusting for inflation. This apparent increase is largely a result of ridership declines at many agencies. At a few agencies, expenditures per passenger trip apparently declined because ridership increased.

At two agencies, San Antonio and New York City, both marketing expenditures per passenger trip and ridership increased during the 2-year period. San Antonio's ridership increased by 37 percent as its marketing expenditures per passenger increased by 3 percent; New York City's bus ridership increased by 6.4 percent, while its per-passenger marketing expenditures increased by 23 percent. To attribute ridership changes to marketing behavior, additional cases and more detailed information--particularly about the timing of expenditures and changes in demand--would be required. However, these two cases provide potential support for the notion that marketing expenditures can effectively increase ridership in different types of transit markets. Marketing expenditures per passenger mile increased by 32 percent, on average, but the bulk of the increase is again the result of substantial declines in the number of passenger miles of travel in most of these areas.

## COMPONENTS OF MARKETING EXPENDITURES

Section 15 defines marketing expenditures in four functional categories: customer services, promotion, planning, and market research. Customer services are sometimes described as selling-related activities, whereas the remaining categories are termed marketing-support activities. Each of these four functional categories will be described further.

### Customer Services

As defined for Section 15 reporting purposes, customer services refers to public relations, customer relations, charter service, telephone information, and related activities. This category of marketing expenses thus includes production of materials such as timetables and system maps. Table 5 presents expenditures on customer service activities by the 18 agencies in 1983, both in absolute terms and as a share of all marketing expenditures. In 1983, the 18 agencies spent more than $18 million on customer service activities, an average of more than $1 million per agency.

Customer service expenditures accounted for more than 50 percent of total marketing expenditures for the 18 agencies and for at least 40 percent of marketing expenditures at most of the individual agencies. This ratio is not unusual in the transportation industry, which is heavily reliant on information exchange. A substantial portion of airline marketing costs, for example, is accounted for by commissions paid to travel agents for booking passenger flights and for communications systems to support airline information services.

On average, customer service expenditures increased by 10 percent from 1981 to 1983, as also indicated by the data in Table 5. As a share of all marketing costs, these expenditures declined by about 1 percent over the time period, possibly reflecting the decline in ridership at most agencies. The relative stability of customer service costs in relation to all marketing expenditures suggests that providing information is viewed as an essential part of selling services such as transportation; more years of data could confirm this hypothesis.

### Promotion

Promotion as defined for Section 15 reports comprises both advertising and promotional activities, including newspaper, billboard and other advertising, press

**TABLE 5 Expenditures on Customer Services by 18 Agencies**

| Transit System | Expenditure on Customer Services (1983) ($) | Change in Customer Service Expenditure (1981-1983) | Customer Service Share of Total Marketing (1983) | Change in Customer Service Share of All Marketing (1981-1983) |
|---|---|---|---|---|
| Orange County TD | 526,752 | 0.09 | 0.32 | 0.24 |
| Minneapolis MTC | 991,778 | -0.12 | 0.42 | 0.03 |
| San Antonio–VIA | 534,300 | 0.43 | 0.36 | 0.01 |
| New York CTA | 743,265 | -0.02 | 0.48 | -0.11 |
| Santa Clara County TA | 2,934,728 | 0.90 | 0.79 | 0.40 |
| Philadelphia–SEPTA | 490,416 | -0.16 | 0.36 | -0.19 |
| Detroit–SEMTA | 1,408,202 | 0.12 | 0.47 | 0.15 |
| Chicago TA | 468,311 | -0.19 | 0.28 | -0.32 |
| Pittsburgh–PATCO | 1,037,911 | 0.15 | 0.64 | -0.02 |
| Seattle METRO | 2,531,941 | 0.46 | 0.75 | -0.14 |
| Boston–MBTA | 308,671 | -0.26 | 0.39 | -0.28 |
| Atlanta–MARTA | 360,060 | -0.26 | 0.62 | 0.17 |
| Cincinnati–SORTA | 465,403 | 0.46 | 0.32 | -0.22 |
| San Diego TC | 784,768 | 0.44 | 0.62 | -0.10 |
| St. Louis–Bi-State | 1,465,447 | -0.12 | 0.72 | 0.10 |
| Denver–RTD | 1,284,193 | -0.20 | 0.67 | 0.14 |
| Alameda-Contra Costa | 999,855 | -0.17 | 0.50 | -0.05 |
| Dallas TS | 695,565 | 0.31 | 0.58 | -0.05 |
| Total | 18,031,566 | | | |
| Average | 1,001,754 | 0.10 | 0.52 | -0.01 |

Note: Acronyms for transit systems are defined in Table 1.

releases, and related activities. It includes services provided by the transit agency as well as professional and technical services hired from outside firms. The data in Table 6 indicate that the 18 agencies spent more than $9 million on promotion in 1983, or slightly more than $500,000 each, on average. Promotional expenditures accounted for more than 29 percent of all marketing expenditures.

On average, the 18 agencies spent less on promotion than three other transportation firms examined, including two intercity bus companies, as indicated by the data in Table 3. The difference is particularly striking for the ratio of promotion (or advertising) costs to operating expenses, which was 0.007 for the reporters, compared with 0.017 for Delta Airlines, 0.024 for Trailways Lines (1984 data), and 0.044 for Greyhound Lines (Delta Air Lines 1984 Annual Report; 9,10).

Promotional expenditures increased from 1981 to 1983 by about 45 percent, on average, as indicated by the data in Table 6. However, the rate of change at individual agencies varied widely, with Seattle, Cincinnati, and San Diego indicating large increases and many other agencies indicating a decline in promotional costs. Possible factors that could explain the wide variation over the 2-year period include new services or facilities construction, changes in hours or routes of service, and changes in funding levels and sources, which may have been accompanied by advertising campaigns. Such campaigns might last only a few months, but could cause large year-to-year cost variations. As a share of all marketing expenses, promotion also increased by 17 percent on average, again with wide variation among systems.

### Planning

Section 15 requirements simply define this category of marketing expenditure as including all long-range and regional transit planning and analysis activities. Both agency salaries and outside services are included. Planning expenditures amounted to $4.4 million for the 18 agencies in 1983, or nearly $250,000 per agency, on average, as indicated by the data in Table 7. Planning expenditures were about 15 percent of overall marketing costs.

Planning expenditures increased by about 10 percent between 1981 and 1983, as indicated by the data in Table 7. In relation to total marketing expenditures, planning expenses declined by an average 7 percent during the same time period. It is possible that the decrease in planning expenditures is related to lower capital outlays and more or less static development at many agencies.

### Market Research

For Section 15 reporting purposes, market research activities comprise consumer behavior research and transit service demand surveys for service development and changes. Market research is central to managing transit services with a marketing (or consumer) orientation because it supplies the information on which to base strategy. The 18 agencies being studied spent a total of $1.4 million on market research in 1983, less than on any of the other three marketing activities. On average, the agencies spent more than $76,000, as indicated by the data in Table 8. Because five agencies spent nothing, the average for those undertaking any market research was actually more than $100,000. Market research expenditures were about 5 percent of overall marketing costs in 1983.

Average expenditures on market research by the 18 agencies increased by almost 40 percent from 1981 to 1983; however, this figure is misleading because San Diego's expenditures increased more than tenfold during this time period, as indicated by the data in Table 8. Without the San Diego data, mean expenditures are observed to have decreased by nearly 16 percent. The same holds true for market research expenditures as a share of all marketing costs. An apparent average increase of 7 percent becomes a decrease of more than 22 percent when San Diego is omitted from the calculation.

## SUMMARY AND CONCLUSIONS

Cost data on bus marketing from the 18 transit agencies examined suggest that they have not yet adopted a marketing approach to transit management, particu-

**TABLE 6 Expenditures on Promotion by 18 Agencies**

| Transit System | Expenditure on Promotion (1983) ($) | Change in Promotion Expenditure (1981–1983) | Promotion Share of Total Marketing (1983) | Change in Promotion Share of All Marketing (1981–1983) |
|---|---|---|---|---|
| Orange County TD | 825,789 | -0.03 | 0.51 | 0.11 |
| Minneapolis MTC | 664,340 | -0.17 | 0.28 | -0.03 |
| San Antonio–VIA | 555,150 | 0.43 | 0.38 | 0.01 |
| New York CTA | 120,278 | -0.47 | 0.08 | -0.52 |
| Santa Clara County TA | 754,784 | -0.17 | 0.20 | -0.39 |
| Philadelphia–SEPTA | 608,739 | 0.37 | 0.45 | 0.31 |
| Detroit–SEMTA | 946,837 | -0.23 | 0.32 | -0.20 |
| Chicago TA | 844,745 | 0.52 | 0.51 | 0.28 |
| Pittsburgh–PATCO | 331,571 | 0.06 | 0.20 | -0.10 |
| Seattle METRO | 593,647 | 5.48 | 0.18 | 2.82 |
| Boston–MBTA | 239,455 | 0.34 | 0.30 | 0.31 |
| Atlanta–MARTA | 187,984 | -0.44 | 0.32 | -0.12 |
| Cincinnati–SORTA | 761,150 | 1.40 | 0.52 | 0.29 |
| San Diego TC | 299,234 | 1.37 | 0.23 | 0.48 |
| St. Louis–Bi-State | 202,702 | -0.27 | 0.10 | -0.09 |
| Denver–RTD | 551,913 | -0.26 | 0.29 | 0.06 |
| Alameda-Contra Costa | 425,028 | -0.24 | 0.21 | -0.13 |
| Dallas TS | 226,429 | 0.35 | 0.19 | -0.02 |
| Total | 9,139,775 | | | |
| Average | 507,765 | 0.45 | 0.293 | 0.17 |

Note: Acronyms for transit systems are defined in Table 1.

TABLE 7 Expenditures on Planning by 18 Agencies

| Transit System | Expenditure on Planning (1983) ($) | Change in Planning Expenditure (1981–1983) | Planning Share of Total Marketing (1983) | Change in Planning Share of All Marketing (1981-1983) |
|---|---|---|---|---|
| Orange County TD | 98,337 | -0.67 | 0.06 | -0.62 |
| Minneapolis MTC | 360,365 | -0.25 | 0.15 | -0.13 |
| San Antonio–VIA | 327,155 | 0.78 | 0.22 | 0.26 |
| New York CTA | 694,262 | 0.65 | 0.45 | 0.50 |
| Santa Clara County TA | 18,579 | -0.93 | 0.00 | -0.95 |
| Philadelphia–SEPTA | 142,892 | -0.13 | 0.11 | -0.17 |
| Detroit–SEMTA | 511,742 | 0.05 | 0.17 | 0.09 |
| Chicago TA | 350,027 | 0.35 | 0.21 | 0.13 |
| Pittsburgh–PATCO | 255,884 | 0.57 | 0.16 | 0.33 |
| Seattle METRO | 197,641 | 0.44 | 0.06 | -0.15 |
| Boston–MBTA | 204,186 | 0.76 | 0.26 | 0.71 |
| Atlanta–MARTA | 30,728 | -0.63 | 0.05 | -0.41 |
| Cincinnati–SORTA | 217,839 | 1.79 | 0.15 | 0.50 |
| San Diego TC | 149,396 | 0.20 | 0.12 | -0.25 |
| St Louis–Bi-State | 221,119 | -0.50 | 0.11 | -0.38 |
| Denver–RTD | 81,205 | -0.79 | 0.04 | -0.70 |
| Alameda-Contra Costa | 582,572 | 0.09 | 0.29 | 0.25 |
| Dallas TS | 1 | 0.00 | 0.00 | -0.27 |
| Total | 4,443,930 | | | |
| Average | 246,885 | 0.10 | 0.15 | -0.07 |

Note: Acronyms for transit systems are defined in Table 1.

larly insofar as that implies investment in consumer research. At more than one-half of the agencies, overall marketing expenditures declined in relation to operating expenses during the 2-year period examined. The agencies spent less than other transportation firms on promotion in relation to operating expenses. Particularly striking is the low allocation of resources to market research, which accounted for 5 percent or less of most marketing budgets in 1983. For instance, five agencies spent no money on market research in the 3 years under study. Although the marketing costs of only 18 agencies were analyzed, these agencies are much larger than average, and likely spend more on marketing than the average agency.

On the other hand, several agencies increased their marketing budgets in the years under study, some by substantial amounts. It is noted, however, that increased expenditures are not evidence of effectiveness. It would be particularly helpful to be able to relate marketing expenditures to a change in demand for transit service--in other words, to gauge the productivity of marketing expenditures. Preliminary work in this regard suggests that marketing is subsidiary to population density, fares, and level of service in determining transit ridership, but that within marketing customer service may be more important than promotion; work on this topic was completed for the author in May 1985 by J. Murayama and M. Fukuhara.

Several issues are suggested for additional analysis. One area involves variations in marketing costs from one transit agency to another. What accounts for these differences? To what extent are they under the control of the transit agency? More fundamentally, it would be useful to know what practices

TABLE 8 Expenditures on Market Research by 18 Agencies

| Transit System | Expenditure on Market Research (1983) ($) | Change in Market Research Expenditure (1981-1983) | Market Research Share of Total Marketing (1983) | Change in Market Research Share of All Marketing (1981-1983) |
|---|---|---|---|---|
| Orange County TD | 175,771 | -0.22 | 0.11 | -0.10 |
| Minneapolis MTC | 341,449 | 0.00 | 0.14 | 0.16 |
| San Antonio–VIA | 52,886 | -0.43 | 0.04 | -0.60 |
| New York CTA | 0 | -1.00 | 0.00 | -1.00 |
| Santa Clara County TA | 12,843 | 0.06 | 0.00 | -0.21 |
| Philadelphia–SEPTA | 107,975 | 0.06 | 0.08 | 0.01 |
| Detroit–SEMTA | 116,738 | 0.05 | 0.04 | 0.08 |
| Chicago TA | 0 | -1.00 | 0.00 | -1.00 |
| Pittsburgh–PATCO | 0 | 0.00 | 0.00 | 0.00 |
| Seattle METRO | 61,914 | 1.21 | 0.02 | 0.30 |
| Boston–MBTA | 35,363 | -0.38 | 0.04 | -0.40 |
| Atlanta–MARTA | 4,322 | -0.71 | 0.01 | -0.55 |
| Cincinnati–SORTA | 6,956 | -0.89 | 0.00 | -0.94 |
| San Diego TC | 41,862 | 10.34 | 0.03 | 6.09 |
| St. Louis–Bi-State | 144,482 | -0.02 | 0.07 | 0.22 |
| Denver–RTD | 0 | -1.00 | 0.00 | -1.00 |
| Alameda-Contra Costa | 0 | 0.00 | 0.00 | 0.00 |
| Dallas TS | 278,997 | 0.59 | 0.23 | 0.16 |
| Total | 1,381,558 | | | |
| Average | 76,753 | 0.37 | 0.05 | 0.07 |

Note: Acronyms for transit systems are defined in Table 1.

result in more effective marketing expenditures. Data needs for addressing these and similar questions include the following:

- A larger set of marketing expenditure data to control for expenditure variations attributable to size, mode, or both;
- More accurate ridership data to improve the reliability of estimates of year-to-year change in demand;
- More definitional specificity for categories of marketing expenses to ensure more consistency across agencies; and
- More precise data on transit service area populations to improve estimates of market share.

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# Prospects for Differential Transit Pricing in the United States

JOEL E. MARKOWITZ

ABSTRACT

For several decades, planners and economists have been urging public transportation agencies to adopt fares that vary by either the cost of providing service or by the value or benefit of the service to the user. It has been argued that differentiated fares would be both more efficient and more equitable than the more common practice of having a uniform fare level for all services at all times. Although many transit agencies have some form of fare differentiation, few have adopted a fare differential that is near the variety or extent of those that have been recommended. This research was designed to better understand the reasons for adoption or nonadoption of fare differentials, and the factors that might lead to changes in the future. A self-completion questionnaire on transit fare attitudes and opinions was completed by 165 transit professionals representing 63 U.S. transit systems (including all 44 of the largest systems). Respondents overwhelmingly expressed support for a wide range of fare differentials. However, they balanced this support with pragmatic concerns about the adequacy of their analytical tools to provide the necessary policy guidance, the marketability of more complex structures, and the ability of their fare collection systems to adapt to such structures. Prospects for increased application of differential transit pricing will depend on the following: (a) making certain that differentiated fares are appropriate to the local setting; (b) improving analytical tools to accommodate a range of fare differentiation options while providing timely, policy-relevant, and conclusive findings; and (c) improving the technology of fare collection equipment to adapt to more complex fare structures without creating operational problems. All three areas are amenable to continued research and development.

For several decades, planners and economists have been urging American transit agencies to adopt more finely differentiated pricing policies that would set fares for different types of trips or travelers depending on the cost of providing services, the value or benefit to users, or the patrons' relative ability to pay. Regardless of the specific rationale used, fare differentiation has been incorporated into the standard advice on how to improve revenue generation and operating efficiency while maintaining service to the public (1-5). Proponents have argued that fares based on such principles would be more efficient, more equitable, or both.

More recently, the federal government has joined the chorus with an active promotion of fare differentiation, including

- Sponsoring demonstration projects in pricing variations (6);
- Soliciting proposals for innovative pricing projects (7);
- Sponsoring two national conferences on transit pricing (1979 and 1981), and a national televised conference in eight cities (1983) (8,9); and
- Beginning a Resource Center on Transit Pricing to provide technical assistance to local agencies on all aspects of transit fare (10).

Despite this consistent stream of advice, relatively few U.S. transit agencies have adopted even one type of fare differential. Innovative transit pricing policies appear to be bold and infrequent exceptions to the rule. This research tried to isolate some of the reasons for the apparent failure of expert advice to penetrate actual local policy making.

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## RESEARCH APPROACH

### Framework

There are many possible explanations for the relative non-use of fare differentials. Two general areas were proposed for investigation:

- Organizational environment: Are there institutional or political settings in which fare differentials might not be proposed, or in which this might not work?
- Individual characteristics: Are professionals in the transit industry personally disposed to promote or oppose fare differentiation? Is the standard advice known and understood by those expected to act on it?

Addressing these questions first requires an understanding of the fare policy-making process. It turns out that relatively little work has been directed specifically at describing how transit fare policy decisions are made. One gap in previous research appears to have been the lack of systematic, quantifiable, national data on the transit fare policy process. To help close that gap, a self-completion questionnaire was designed for mailing to transit professionals involved in setting fares. Although others are involved in the process (policy board members, agency operating personnel, riders, and news media, among others), transit professionals must be considered the day-to-day experts at describing their fare policies.

Survey Design and Sample

The survey, conducted in 1983-1984, solicited ideas on fare policy from a large national cross section of transit professionals. The sample included all 44 of the largest U.S. transit systems (those with 250 vehicles or more, according to the 1981 federal statistical compilation, the most current at the time of the sample selection), and 19 other systems that either had time-of-day pricing or had indicated an interest in pricing by their attendance at the 1983 teleconference on Transit Fare Policy and Pricing. The 1981 federal statistics indicated that these agencies accounted for about 75 percent of all U.S. transit vehicles and vehicle-miles of service and about 85 percent of transit passenger trips and passenger-miles.

Agency general managers and their immediate assistants were always included; other staff (typically division or department heads) were included from all functions relevant for fare policy (administration, finance, planning, public information, and operations) in which individuals responsible for these functions could be specifically identified. All 63 agencies targeted responded with one or more usable questionnaires, and 67 percent of all questionnaires were returned in usable form. One respondent from each agency was identified as the key respondent for certain analyses. These 63 individuals were selected based on their seniority, rank, and influence in their agencies (as reported in the questionnaire), and by the completeness of their responses. The key respondents were relied on to describe their perceptions of the political and institutional environment and the fare policy process in their agencies (see the section on Organizational Environment), and all 165 respondents' questionnaires were used to analyze attitudes and personal characteristics (see the section on Individual Characteristics and Attitudes).

Limitations of the Approach

The survey sample was not intended to be a simple random sample from a known population, projectable to the whole. The intention was rather to obtain a broad range of responses from a cross section of transit industry experts responsible for developing and implementing fare policies. The assumption was that these professionals' perceptions and opinions are key to understanding the use and non-use of fare differentials, without regard to evaluating the accuracy of those perceptions. The reliance on a one-shot, impersonal, self-completion questionnaire also limits the analysis in that (a) immediate, follow-up questions to probe the reasons for a response were not possible, and (b) a single observation in time does not allow either an assessment of the stability of the recorded perceptions and opinions over time, or establishment of firm, causal links between responses and subsequent agency fare policies. Nonetheless, the high response rate and the interest with which the respondents completed the lengthy questionnaire give some assurance of the reliability of the data.

ORGANIZATIONAL ENVIRONMENT

Four aspects of the organizational environment were examined: the overall setting for the process (motivation for recent fare changes, type of policy board, fare history), the internal influences (organization, staffing, time schedule), the external influences (outside governments, other interest groups, general climate of opinion), and the administrative process. Each of these will be described further.

Overall Setting

The survey and secondary data addressed three elements of the setting for fare policy decisions: the motivation for the fare change, the type of policy board, and an agency's fare history.

The motivation for a fare change may have an influence on the types of alternatives that are considered and adopted. As can be observed in Figure 1, equal numbers of respondents reported that the last fare change was prompted by the normal, annual budget cycle and by a financial crisis. In only a few cases the fare change was the result of a specific, previously adopted schedule for such actions, and in even fewer cases the fare change was the result of actions of other levels of government, presumably providers of operating subsidies.

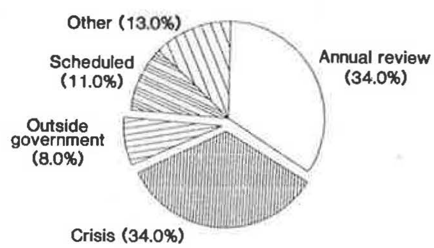


FIGURE 1 Most important reasons for the last fare change.

The respondents leave a somewhat bleak picture for the measured consideration of fare policies that depart from past practices--more than 40 percent of systems are forced into a fare change by a financial crisis or by other government agencies, and another one-third deal with fares only on an incremental, annual basis. In such settings, strategic, long-term fare planning to evaluate a broad range of innovative policy alternatives may not be possible.

Two-thirds of the agencies (43 out of 63) have policy boards with appointed, rather than directly elected, members. Such boards might be expected to be more favorable than elected boards toward innovations in fare policy because they would be more insulated from direct, adverse voter reactions. Key respondents characterized their boards as generally politically conservative or moderate, which could incline them to look favorably on cost-based fares.

There were wide variations in past fare-setting practices. Agencies surveyed had as few as one to as many as five fare changes in the 7 years for which comparable data were available, 1977 to 1984. The average was about three changes, that is, one every other year. The change in the adult base fare for these agencies during that period varied from a 50 percent reduction to a 300 percent increase, with an average change of 88 percent (or 23 percent per each of three fare changes, compounded). Although it is difficult to generalize from such widely varying data, the history appears to be one of infrequent, relatively large changes in fares. This might work against the introduction of new types of fare structures, which may need to be more frequently reexamined and fine-tuned.

## Internal Influences

Internal influences on fare policy include the number of different staff and departments involved, the speed of the policy process, and the use of outside assistance. On average, six staff members are involved in the process (mean 6.7, median 5), and it usually takes 6 months to go from initial discussion to adoption of fares. All five departments typically found in transit agencies (finance, administration, planning, operations, and public information) were mentioned as being involved in the process, but the finance or administration departments generally have the lead. The lesser role of operations and public information departments suggests that fare proposals might be developed in relative isolation rather than as part of an overall agency strategy linking service planning and marketing. In addition, the internal process is almost always the exclusive domain of staff. Most agencies (84 percent) reported that outside consultants played no direct role in the process. In general, the internal process appears to be a relatively swift administrative proceeding with few staff directly involved.

## External Influences

Outside influences on the fare process may include other levels of government, other interest groups, and the general climate of opinion toward fare changes. Outside governmental entities, principally cities, play a role in more than 60 percent of the cases (40 out of 63 transit agencies). This high level of intergovernmental activity, particularly for the larger systems, may be related to the presence of several layers of financial assistance, each of which may exact its price. It may also reflect the fact that appointed boards may include elected officials from the cities and counties in a transit agency's service area. Although involvement of many governmental agencies could complicate the fare decision process, it also offers opportunities for introducing fare differentials to meet the varying needs of the participants. This appears to have been the case in Washington, D.C. (11).

In addition to other governmental units, many outside groups could potentially be involved in the transit fare process. With five categories of outside interest groups listed in the survey (local business, news media, riders, environmentalists and unions), more than 40 percent of the agencies reported that at most one group was active. News media and riders were identified as being somewhat too deeply involved in the process, whereas business, environmental, and labor groups rarely got involved. This suggests that transit fares may not generate a great deal of general public interest, which is confirmed by only 20 percent of the agencies describing the last fare change as more than moderately controversial. Fare differentials might be more easily considered where little controversy exists.

## Administrative Process

There are many more or less standard steps in the administrative process of fare revision. Respondents were asked in an open-ended question to describe what they considered to be the most difficult steps in the process for setting fares. These were coded into seven general categories. Table 1 gives the key respondents' views of the most difficult steps in the process for setting fares. Approximately equal numbers indicated staff actions (the first three categories listed) and indicated political steps (the next three categories) to be the more difficult steps.

**TABLE 1 Most Difficult Steps in Process for Setting Fares**

| | Multiple Response | |
|---|---|---|
| | No. | Percent |
| Staff/technical steps: | | |
| Initial decision | 8 | 6.3 |
| Rider, revenue analysis | 22 | 17.2 |
| Other staff, tech step | 30 | 23.4 |
| Subtotal | 60 | 46.9 |
| Political steps: | | |
| Board action, decision | 29 | 22.7 |
| Public involvement | 25 | 19.5 |
| Other political, government | 9 | 7.0 |
| Subtotal | 63 | 49.2 |
| Other steps | 5 | 3.9 |
| Total | 128 | 100.0 |

Remembering that these viewpoints are those of relatively senior respondents, this suggests that transit professionals do not view the political process as particularly burdensome. The concerns about difficulty at the staff level may be partly explained by opinions on the technical side of fare analysis (see the section on Personal Characteristics, Training, and Technical Knowledge).

## Summary--Organizational Environment

An overall picture of the transit agency fare-setting process emerges from the descriptions of the key respondents. In general, most factors examined appear to be favorable to the introduction of fare differentials, although some are two-edged.

First, the process is a relatively swift one, involving few staff, led by the finance or administration departments, and rarely using outside consultants. Although speed and a small number of active individuals create an opportunity for decisive action to introduce new fare structures, the somewhat narrow viewpoints of the lead departments and the lack of outside experts to provide new ideas may work against innovation.

Second, policy boards, which tend to be appointed rather than directly elected, are generally mildly conservative to moderate in their political leanings. A somewhat politically insulated board that is sensitive to cost-based arguments should present a good environment for introducing fare differentials.

Third, outside governmental units may often be involved in fare setting, but few outside interest groups are similarly involved. This may partly explain the relatively noncontroversial nature of fare changes. Although a political debate limited to a few groups should be more easily managed by an agency wishing to introduce a major shift in fare policy, the inclusion of other governmental agencies could severely restrict the options available.

Fourth, transit professionals view the internal, staff-level, technical steps in the process to be as difficult as the more political steps. Where staff-level steps are considered to be the most difficult, introduction of fare differentials might be relatively easier, provided that the staff had the capability to analyze such fare options.

In contrast to these factors that could favor the introduction of differentials, only a few situations existed in the policy process that appear to present substantial barriers. Where political steps are considered to be the most difficult, radical departures from current fare policies may not even be proposed. Where fare decisions are made relatively infrequently, and may often be made in response to a financial crisis or the requirements of other levels of government, little opportunity may exist to evaluate and introduce new types of fare structures.

## INDIVIDUAL CHARACTERISTICS AND ATTITUDES

Whereas only the 63 key agency respondents were relied on for information about agency-wide processes, the responses of all 165 surveyed individuals involved in fares are important for understanding the potential influence of their characteristics and attitudes on fares. Two aspects of this point are addressed here: individual predispositions toward fare differentials (including personal characteristics, training, fundamental beliefs, and perceptions of problems and solutions) and individual evaluations of specific fare options.

### Individual Predispositions Toward Fare Differentials

#### Personal Characteristics, Training, and Technical Knowledge

It was assumed that certain attributes of the professionals involved in the fare policy process might influence their evaluation of fare differentials. Because such characteristics exist before any specific fare policy situation, they were considered to be predisposing factors rather than direct causal influences on policy decisions. Fare differentials might be more likely to occur in agencies in which those involved in the process are younger, more highly educated, and trained in economic concepts. Younger persons are assumed to be both more highly educated and to have been trained during the period when the arguments for fare differentials have been most pronounced. One-half of the respondents are under 40 years of age, about 60 percent have college degrees, and more than one-half hold degrees in fields in which they are likely to have been exposed to economic analysis, or at least to the vocabulary of economics. All this suggests that there are significant numbers of individuals in the transit field who could be expected to understand and evaluate arguments for fare differentials.

However, beyond this general level of understanding is the need for a deeper technical knowledge in order to fully participate in the consideration of fare differentials. Four aspects of technical knowledge were covered in the survey: knowledge of elasticity (the proportional change in transit usage or revenue from a change in fares), knowledge of cost differences, sources of information, and opinions of fare analysis methods in general.

Basic to any evaluation of fare policy options is the analysis of the probable effects of proposed fare changes on revenue and ridership. Nearly all respondents said they were familiar with fare elasticity, the key concept for conducting such analyses. Although 40 percent mentioned only one of five possible types of elasticity measures, nearly one-third said that they or their agencies have used three or more measures. The measures mentioned most often were those developed specifically for their system and the Simpson-Curtin rule. [This rule of thumb (a loss of 0.3 percent in ridership for each 1 percent increase in fares) has been widely used in the U.S. transit industry since its introduction by Curtin (12).] Less often mentioned were use of measures

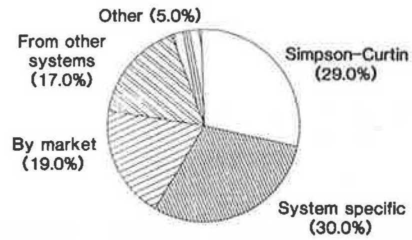


FIGURE 2 Elasticity measures known or used.

from other systems and measures broken down by ridership type (see Figure 2).

Whereas nearly all respondents knew about elasticities, 40 percent said that they or their agencies had not determined the costs of providing different types of services, a key ingredient in developing cost-based pricing differentials. For those who responded, cost distinctions by service type, route, and fixed versus variable categories were mentioned about equally. Determining average versus marginal costs was mentioned least frequently, which implies that the distinctions mentioned were probably based on systemwide average costs (see Figure 3).

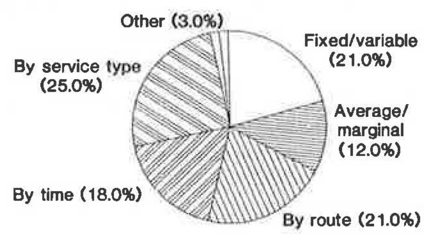


FIGURE 3 Cost differences known or used.

Four different information sources on fares were listed (colleagues within the agency, colleagues outside, professional journals, and research reports). Relying on colleagues, in and outside the agency, was mentioned most often (68.7 percent), with research reports ranked third (19.1 percent). More than 60 percent reported only one or two sources of information. Fewer than one-quarter could name any specific journals or reports that they found helpful (see Figure 4).

One-third of the respondents mentioned some direct involvement in federally sponsored activities relating to fares. This survey was conducted after the 1983 teleconference on Transit Fare Policy and Pricing, but before the introduction of UMTA's Pricing

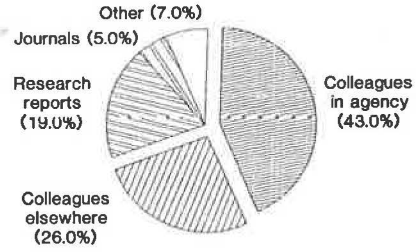


FIGURE 4 Sources of information on fares.

TABLE 2 Assessment of Fare Analysis Methods

| Do you agree or disagree that: | Strongly Disagree (%) | Mildly Disagree (%) | Mildly Agree (%) | Strongly Agree (%) | Total (%) | No. |
|---|---|---|---|---|---|---|
| Available methods are reliable | 8.9 | 25.3 | 58.9 | 6.8 | 100.0 | 146 |
| Never enough good information | 6.7 | 20.7 | 46.0 | 26.7 | 100.0 | 150 |
| Available method easy to explain | 14.0 | 43.4 | 37.8 | 4.9 | 100.0 | 143 |
| Need simpler, quicker methods | 5.2 | 24.4 | 42.2 | 28.1 | 100.0 | 135 |
| Nobody understands how people respond to fare changes | 10.6 | 33.1 | 43.7 | 12.6 | 100.0 | 151 |

Resource Center technical assistance program. However, based on this response UMTA's formal conference and report publication approach does not appear to have reached as many of the target professionals as might have been expected, given the continued emphasis UMTA has placed on the subject.

Transit professionals appear to be ambivalent about the technical tools of the trade for predicting the impact of fare changes (see Table 2). Even if transit professionals are knowledgeable and well informed, they need to have confidence in applying the available analytical methods to complex fare differential proposals. This includes the base data available for analysis, the specific types of elasticity measurement used, the mathematical form of the predictive models, and the computational environment. Although they consider the available methods to be generally reliable ("as reliable as can be expected"), the respondents also believe that they are not easy to explain and need to be simpler to use. Further, reflecting perhaps on the aforementioned situation of having to conduct analysis under time pressure, they agree that there is never enough good information for a thorough analysis. Surprisingly, more than one-half agreed that not enough is understand about how people respond to fare changes, implying that current models may be inadequate representations of reality. This ground appears to be fertile for development of new analytical tools.

### Fundamental Beliefs

In addition to personal characteristics, another set of potential predisposing factors is that of fundamental beliefs about how certain aspects of fare policy are or should be considered. Such beliefs are presumed to be relatively stable over time, as opposed to opinions about specific, current issues that might be more easily changed. Three such beliefs were examined in the survey: conceptions of equity in fares, the role of politics versus technical considerations in fare decisions, and the service versus economic view of public transit's role.

One of the recurring concerns in fare policy formulation is that the resulting fare structure must be equitable, but there are no universal standards for judging equity. To understand how transit professionals perceive the term, respondents were asked to choose among alternative definitions of equity. The most frequently mentioned responses were those definitions that dealt with equally sharing the cost of services and with basing fares on value or benefit received (see Tables 3 and 4). Nearly 90 percent of respondents mentioned either or both of those views of equity. Either one may be considered consistent with support for fare differentials.

Relatively few preferred definitions dealing with ability to pay or with lower fares for the disadvantaged. Similarly, respondents were virtually unanimously opposed to allowing discount fare recipients to ride free during the off-peak periods, or basing fares on rider incomes. According to comments frequently volunteered by respondents, this was due to their perception that transit agencies have been forced to provide a social welfare function that rightfully belongs to other agencies and levels of government. More than 60 percent of respondents agreed that direct user-side subsidies to low-income persons, an often-mentioned but little-used technique, should eventually replace general fare discounts.

Table 5 gives respondents' beliefs about two other

TABLE 3 Views on Equity in Fare Setting: Meaning of Equity

| | Most Important | | Multiple Responses | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| Ability to pay | 9 | 5.9 | 24 | 10.2 |
| Value/benefit received | 53 | 34.6 | 84 | 35.7 |
| Sharing cost equally | 68 | 44.4 | 87 | 37.0 |
| Lower fare for disadvantaged riders | 3 | 2.0 | 20 | 8.5 |
| Other | 20 | 13.1 | 20 | 8.5 |
| Total | 153 | 100.0 | 235 | 100.0 |

TABLE 4 Respondents Mentioning Economic-Based Views of Equity (value received or cost-sharing)

| | No. | Percent |
|---|---|---|
| Mentioned neither | 22 | 13.3 |
| Mentioned either one | 115 | 69.7 |
| Mentioned both | 28 | 17.0 |
| Total | 165 | 100.0 |

TABLE 5 Views on Politics and the Role of Transit

| | No. | Percent |
|---|---|---|
| How much do political or technical considerations determine fare structures? | | |
| Entirely based on technical consideration | 2 | 1.2 |
| Mostly technical, some political | 56 | 34.6 |
| About evenly split, technical and political | 58 | 35.8 |
| Mostly political, some technical | 46 | 28.4 |
| Entirely political | 0 | 0 |
| Total | 162 | 100.0 |
| How should public transit be viewed? | | |
| Treat transit like other service-oriented government functions, such as police and fire | 59 | 36.4 |
| Treat transit like other economic-oriented government enterprises, such as water or other utilities | 75 | 46.3 |
| Combination of the two | 28 | 17.3 |
| Total | 162 | 100.0 |

ideological perspectives affecting fares. First, respondents are nearly evenly split on whether fare decisions are mostly influenced by politics, technical issues, or a mixture of the two. Those who believe politics is relatively more influential may perceive that there are too many political uncertainties or risks involved in pursuing innovative pricing proposals. However, the even distribution suggests that there are few cases in which technical judgment is thrown to the wind; no respondents believed that decisions were purely political. The respondents appear to have a realistic expectation that technical analysis can influence fare decisions, but that it will be balanced by political considerations.

The second perspective is the view of transit primarily as a public service, such as police or fire, or more as an economic enterprise. Respondents appeared to lean toward the economic orientation, consistent with their previous ranking of revenue generation as a key objective. However, nearly as many endorsed the service orientation, and some believed that transit should be viewed as a mixture.

It might be expected that those who believe both that technical considerations influence fare decisions and that transit should be viewed as an enterprise would be most favorable toward differential pricing.

## Perceptions of Problems and Solutions in Fare Policy

The final set of potential predisposing factors that was considered was the respondents' opinions on a number of fare policy issues: objectives, constraints, practical implementation concerns, and financing. The data in Tables 6 and 7 indicate that transit professionals are principally concerned with the revenue generation objective of fares. In keeping with their views on equity, respondents were less interested in using fares to provide mobility for low-income riders. Respondents were also less interested in using fares to change automobile or transit travelers' behavior. More than one-half of them believe that fares should encourage new ridership and that fare simplicity is a very important objective, and 87 percent agree that fares should be aggressively used to market transit. Most respondents agreed that fares should be regularly increased to cover increasing costs (88 percent), and many believed that further subsidy cuts will lead to more fare increases (74 percent). Many also agreed that continued fare increases will bring large losses in ridership (59 percent). Still, most believed that all other revenue sources and cost reductions should be pursued before increasing fares (75 percent), and few would tie fare increases to service improvements (37 percent). On practical matters in implementing fares, respondents were most concerned with the ease in marketing and in the perceived limitations imposed by existing fare collection equipment.

The impression created from these responses regarding fare policy objectives and constraints is that fare increases are viewed in two somewhat contradictory ways. First, fare increases appear to be a necessary evil, a duty that must be done only when absolutely necessary, with full knowledge of the likely adverse consequences. The second view is a more positive one of using fares to attract riders and to market transit service as a desirable product. To the extent that fare differentials are viewed as a means of more effectively addressing both concerns (revenue and ridership), these opinions may be considered favorable toward differentials. However, if fare differentials are perceived as being inherently complex, proponents will have to address the concerns expressed about simplicity, marketability, and feasibility with existing fare collection equipment.

With budget constraints always a concern, respondents' attitudes toward two aspects of transit financing were explored in the survey: farebox recovery (the proportion of operating expenses covered by fare revenue) and subsidies. Respondents would favor 40 percent farebox recovery ratios, although the average actual recovery for these agencies is barely one-third. Few believed that transit should try to return to the days of recovering most expenses from the farebox. When asked whether seven sources of revenue, including fares, should be increased, decreased, or kept at current levels, respondents on average believed that three of those sources (gasoline taxes, automobile fees and tolls, and sales taxes) should be increased to fund transit. Professionals appear to be in agreement with the view that transit should be funded from a mix of sources,

**TABLE 6 Opinions on Objectives of Establishing Fares**

| How important are these objectives in establishing fares? | Not Important (%) | Somewhat Important (%) | Very Important (%) | Total (%) | No. |
|---|---|---|---|---|---|
| Provide mobility for disadvantaged | 15.4 | 49.4 | 35.3 | 100.0 | 156 |
| Achieve revenue generation targets | 1.2 | 24.7 | 74.1 | 100.0 | 162 |
| Encourage new ridership | 3.1 | 46.0 | 50.9 | 100.0 | 163 |
| Keep fares simple | 4.9 | 42.3 | 52.8 | 100.0 | 163 |
| Reduce automobile use | 16.0 | 55.6 | 28.4 | 100.0 | 162 |
| Induce riders to change behavior | 28.8 | 54.9 | 16.3 | 100.0 | 153 |

**TABLE 7 Opinions on Fare Policy Issues**

| Do you agree or disagree that: | Strongly Disagree (%) | Mildly Disagree (%) | Mildly Agree (%) | Strongly Agree (%) | Total (%) | No. |
|---|---|---|---|---|---|---|
| Fare should be regularly increased | 1.8 | 10.4 | 50.0 | 37.8 | 100.0 | 164 |
| Improve service first | 15.6 | 46.9 | 24.5 | 12.9 | 100.0 | 147 |
| Use fares to market transit | 2.0 | 10.7 | 57.3 | 30.0 | 100.0 | 150 |
| Reduce costs, raise other revenues first | 3.1 | 22.0 | 37.7 | 37.1 | 100.0 | 159 |
| Subsidy cuts increase fares | 5.7 | 20.1 | 47.8 | 26.4 | 100.0 | 159 |
| Fare increase means large rider losses | 4.6 | 35.9 | 32.7 | 26.8 | 100.0 | 153 |

with riders shouldering less than one-half of the burden. If fare differentials are viewed as a way to enhance farebox recovery, then those who favor increasing the typical recovery ratio to 40 percent would also favor differentials. Those who favor increasing several subsidy sources rather than fares might be expected to be less favorable toward differentials.

### Evaluation of Fare Differential Options

The predisposing factors described were proposed to set the stage for the transit professionals' evaluations of fare differentials. The data in Table 8 indicate the broad support that fare differentials have. Respondents were asked if they believed that each of five kinds of fare differentials was a good or bad idea for an ideal fare structure. According to the responses, 80 percent or more believed distance, time, quality, and cost-based fares were each good or very good ideas. Only in the case of fares based on rider incomes was the response reversed, with 80 percent of professionals believing it to be a bad idea. As noted in the discussion on equity, they reported that this is primarily due to their belief that social service agencies are more appropriate sources for such income-based programs. A summary variable counted mentions two of the most economically based differentials, time-of-day or cost-based fares, as good ideas. More than 60 percent of professionals believe that both are good or very good ideas; nearly 30 percent more said that one or the other was a good idea; only 8.5 percent did not mentioned either. Thus, despite the relatively low incidence of multiple fare differentials in practice, transit professionals are both aware of them and agree in principle that they should be part of an ideal fare structure. The long-standing arguments promoting fare differentials have apparently been effectively transmitted to transit professionals.

TABLE 8 Evaluation of Fare Differential Options

| Would it be a good or bad idea to vary fare according to: | Very Bad Idea (%) | Bad Idea (%) | Good Idea (%) | Very Good Idea (%) | Total (%) | No. |
|---|---|---|---|---|---|---|
| Distance | 0 | 8.3 | 52.6 | 39.1 | 100.0 | 156 |
| Service quality | 5.1 | 16.7 | 59.4 | 18.8 | 100.0 | 138 |
| Time of day | 4.1 | 9.5 | 57.1 | 29.3 | 100.0 | 147 |
| Rider income | 34.4 | 45.7 | 17.9 | 2.0 | 100.0 | 151 |
| Cost of service | 2.6 | 13.8 | 55.9 | 27.6 | 100.0 | 152 |

### Summary--Transit Professionals' Characteristics and Attitudes

Transit professionals involved in the fare process appear to be capable of accepting more differentiated transit pricing in terms of their general attitudes, fundamental beliefs, specific opinions, training, and knowledge. They overwhelmingly support most kinds of differentials, and they are generally comfortable with the analytical terms and tools to handle the requisite analyses, although they recognize that fare analysis methods need to be improved. They report using relatively few sources of information about fares, yet they are well aware of and support fare differentials. This suggests that transit professionals are similar to practitioners in other fields in which ideas from the research literature are informally and unsystematically absorbed in the course of daily work. Transit professionals would favor fundamental changes in fare policies (e.g., more frequent fare increases, reduced use of discounts, and higher fare and farebox recovery levels). However some expressed concerns that potentially limit the application of fare differentials, including concerns about the marketability to the public of more complex fares and the ability of fare collection equipment to handle new fare structures.

## CONCLUSIONS

### Main Findings

In the first place, two current stereotypes have been both confirmed and challenged. The vision of the fare-setting process as an irrational, unpredictable enterprise driven by narrow political interests is rarely found to be tenable. More often, the process is a fairly swift administrative one; a policy board makes choices from a range of options developed by professional staff who are cognizant of the interplay of political considerations. Still, the observation that fares are politically set must always be true to the extent that it is the responsibility of the policy boards to apply their judgment of political and social equity to the technical analysis of options posed by staff.

Another view that also must be discarded is that transit professionals are in a stodgy, conservative industry in which no one is interested in change or new ideas. Regardless of rank, tenure, education, or function, these professionals strongly support basic changes in fare policy and structure, including increased use of fare differentiation, to improve the fiscal viability of these agencies. However, as practicing professionals rather than theoreticians they balance their support with concerns about the adequacy of their analytical tools to provide the necessary guidance, the marketability of fare differentials to the public, and the ability of their fare-collection systems to adapt.

It has already been observed that transit professionals are well aware of the idea of fare differentials, so the first step in the information channel is not a problem. Awareness and agreement were so great that fare differentiation may now have to be considered part of the socialization of transit professionals. The years of repetition about what should be have apparently sunk in--they know what they ought to know.

For almost all of the other major components of the framework as well, the findings appear to indicate potential for increasing the use of fare differentials. Individual professionals involved in the process appear to have the knowledge, abilities, opinions, and beliefs to support increased use of differentiated pricing. A relatively benign decision environment exists for pursuing innovative policies (appointed boards may be more accepting of new policy directions, involvement of relatively few staff and departments simplifies internal decisions, and few outside groups are actively involved to complicate the process). However, a history of infrequent, large fare changes and a reactive orientation (fare policy as a result of incremental, annual decisions or in response to a financial emergency) may work against differentials.

The combination of these attitudinal and institutional factors appears generally to be favorable toward time-of-day pricing and multiple differentials, yet these policies are not widely followed. If almost all the pieces to support fare differentials are in place, but differentiation is still uncommon, then what is left out must be critical.

The data suggest that there may be mundane reasons why this general support for fare differentials may not often get translated into practice. Although transit professionals know what should be done in principle, it is far more difficult to know when and how to implement fare differentials.

## Technical Issues

The professionals must be able to explain to policy makers the consequences of various options. However, respondents reported some lack of confidence in the methods available for fare analysis. The analytical demands for evaluating fare differentials are considerable; more disaggregated data on service costs and ridership demand than are usually maintained in agency files may be needed, and efficient methods for analyzing the more detailed data are often lacking. This situation is compounded by fare policy decisions being made in a short-term or crisis context rather than as part of a long-term, strategic integration of fare policy, service planning, and marketing. There is great pressure on staff to provide a projection of revenue generation that is as accurate as possible. The immediacy of the policy needs drives the analytical approach into the position of having to rely on proven methods, rules of thumb, and data that are easily available. Introduction of unfamiliar terms and methods under this kind of pressure could introduce additional risk into a financial picture already full of uncertainty.

One area in which some change may be possible is in the ongoing professional education of people in transit. There was an uneven response in the national survey on the frequency of agencies actually calculating the relevant cost differences. This suggests that there is a particular need to help transit professionals analyze the cost structure of their services so that they would be able to examine the consequences of applying cost-based pricing.

In response to the survey's open-end questions about issues concerning opportunities for and obstacles to more innovative pricing in transit, one of the problems mentioned frequently was the difficulty in analyzing the trade-offs and disaggregate impact of fare structure, ridership, revenue generation, farebox recovery, and subsidy levels. The emerging development of interactive computer models to compare fare policy options is promising, but their success (presuming they are technically correct and substantively appropriate) may depend on how they are disseminated. Based on the previous observation that transit professionals prefer face-to-face exchange of information, training to develop in-house analytical capabilities in all aspects of fare analysis would appear to be a promising direction for additional federal support. Workshops at industry conferences, traveling training courses, and site visits may thus be the most effective ways of introducing these new tools after they are developed.

Furthermore, given the wide variations in the details of fare structures to meet local requirements, any fare policy model must be easily adaptable by the transit agency staff so that the analysis can be fit to the situation, rather than the other way around. It would behoove developers of such tools to work directly with transit professionals in the initial structuring of what a policy-relevant fare model is supposed to do in the first place.

The other critical requirement for such models is the ability to quickly update them, modify assumptions, and test multiple options in real time. Given the reported frequency of fare changes that respond to financial crises, a great premium must be placed on tools that allow the fastest possible turnaround of analyses that directly address the relevant policy choices. It is not enough to complain that time constraints preclude the analysis of more sophisticated policy options. The methods must be retooled to fit the time demands of the task.

## Operational Feasibility

Even if there were no analytical problems, the concerns about operational feasibility would similarly run up against the time pressures just mentioned. The most frequently mentioned obstacles and opportunities for innovative pricing were in the areas of fare-payment methods and fare-collection equipment. Fare-equipment limitations had been cited in the national survey by 46 percent of respondents as very important and by 41 percent as somewhat important in establishing fare structures. Research and development on practical and reliable on-board bus fare-collection equipment is continuing, but this and further evaluation of self-service fare-collection procedures may be among the most critical factors limiting more finely differentiated fares. It is simply not possible in the short run for a transit agency to independently undertake research and development on new fare-collection technologies. The federal government has sponsored such efforts in demonstrations, and various equipment suppliers are undertaking their own research; however, transit agencies do not have the time, staff, or budget to seriously consider short-term changes in their fare-collection equipment.

Some types of differentials may not actually require new technology (e.g., time-of-day fares can be implemented in some cases by operational rules alone), but the pervasive perception of professionals is otherwise. If nontechnological options for implementing fare differentials can be identified, they should be more widely explained to professionals. If fare differentials can be proposed that do not require equipment changes, they may be more likely to be considered.

## Marketability and Simplicity

Transit professionals appear to believe that differentials are inherently complex, and therefore violate one of their primary fare policy objectives--simplicity. More than one-half of the respondents to the survey said that keeping fares simple and understandable is a very important objective. It took 65 pages to describe a recent fare structure for Washington (in Tariff Number 13, Tariff of the Washington Metropolitan Area Transit Authority on Metrorail and Metrobus Operations within the Washington Metropolitan Area, June 30, 1984); however, this apparent complexity may be deceiving. An individual traveler has to learn only the fare for his trip; transit operating personnel have to know only the fares for the routes they serve. The fear of overly complex fare structures is puzzling, given the generally accepted levels of pricing complexity in everyday life, for instance, with telephone toll calls or postal rates. Travelers may be more amenable to complex fare structures than transit staff and board members believe, if those travelers believe that fares are fairly set and if they are informed about the basis for differences. More market research work must be done to determine whether this penchant for simple fares is justified.

Even if an agency wishes to plunge ahead with differentials, lack of experience with them may create problems in marketing that would have to be thought out ahead of time. Few agencies would have ready-made market research data for planning their marketing strategy for differentiated fares. Again, it would be impossible for most agencies to thoroughly assess marketing options for fare differentials in the short time usually available for fare analysis.

## Directions for Further Research

### Need for Fare Policy Decision Framework

Despite all the promotion of fare differentiation, there is no accepted way to specify the circumstances under which a particular fare differentiation strategy or combination of strategies will produce the most desirable results. This research examined only where fare differentiation is used, not where it should be used. It is entirely possible that current practices differentiating fares are inappropriate; the circumstances under which multiple differentials are warranted, for example, may be limited. Clearly, if a transit system has no particular peaking pattern, time-of-day pricing would make little sense. Similarly, if average trip lengths are short, zone structures would accomplish little. Not only is there no agreement on which fare differentials to apply, there is also little agreement on the ideal magnitude of differences. For instance, respondents to the survey said that the maximum number of zones in a system should be anywhere from 1 to 20 and the zone size from 2 to 15 miles. There can be no standard advice here, but there is a truism: for fares to vary, services or costs must vary.

A favorite policy analytic technique turns the tables on a proposal by asking, If X is the answer, what is the question? (This approach, if not pioneered, was at least broadly practiced by Aaron Wildavsky, among others.) As with any other public policy tool, fare differentiation cannot be a universal technique, suitable in all places and at all times. Every technique has its merits and limitations. What problem does fare differentiation solve? Others have demonstrated that efficiency, equity, or both may be improved by introducing fare differentials of various types. However, a framework for fare policy decision making is completely lacking that systematically leads an analyst or policy maker through the difficult trade-offs among efficiency, equity, and simplicity, while accounting for the real costs of implementing various differentials. If more rational decisions are to be made, they can only occur when the expected benefits are lined up against the total costs of implementing differentials (capital costs for equipment, changes in operational efficiency and schedule adherence, transaction costs to operating personnel and travelers, and gains and losses in political capital). If this kind of information is unavailable to decision makers, one cannot complain about a lack of rationality in fare decisions. Providing such information and an integrating framework is a daunting challenge for further research.

### Remaining Research Agenda

Other areas for further research suggested by this analysis would include the following: (a) pursuing the initial self-completion survey with more in-depth interviews to explore why the transit professionals held certain opinions; knowing the opinions alone and not the reasons for them is a serious shortcoming of this analysis; (b) expanding the framework by soliciting the ideas and opinions of other persons in the fare policy process, particularly policy board members and riders; and (c) structuring more controlled demonstrations of fare differential options to develop more concrete how-to information and to determine if there are optimum mixes of different types and levels of differentials to meet different policy objectives; optimum in this sense must include a political as well as an economic dimension.

## Overall Conclusions

The overall conclusion is that attitudinal and institutional factors do help set the stage for transit fare differentials. In a sense, they may be the necessary, but not sufficient, conditions for adopting such fares. The critical point appears to be with the more pragmatic problems of analysis and implementation. Proponents of fare differentials therefore no longer need to complain that they are not being heard by transit professionals. Instead, they should start addressing these practical issues that have been largely ignored in the literature. However, even if all of those issues were addressed, universal application of fare differentials would not result. In reaching fare policy decisions, policy makers will merge the new factual information with the much more subjective evaluations needed to reach a political consensus that meets local needs.

What explains the apparent non-use of differential pricing in transit? It is neither ignorance nor obstinacy, but three rather simple factors that may govern the outcome:

1. The policy advice may not fit where cost, service, or market variation is limited.
2. The policy advice cannot be convincingly substantiated to staff, policy makers, or the public because of lack of data or lack of confidence in analytical tools.
3. The practical implementation problems (fare collection equipment and procedures, burden on operating personnel, marketability) are not considered or are understated.

The gratifying conclusion is that there is a community of interest among theorists, applied researchers, professional practitioners, and policy makers to take positive steps to respond to these issues.

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# An Initial Analysis of Total Factor Productivity for Public Transit

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ABSTRACT

Improvement of transit performance depends first on the ability to measure performance levels. Introduced is the concept of total factor productivity as a unified measure of transit performance. This concept uses the shift in the cost function as the measure of change in productivity. A three-stage least-squares estimation procedure was used to estimate model parameters. The technique was applied to 20 transit systems. Data were analyzed for the most recent 26-year period. Results indicate that there are no consistent trends in total factor productivity. Productivity appears to increase and decrease in similar amounts year by year, indicating that there is little change. This supports the hypothesis that little technological improvement has occurred in the industry and that management decisions tend to compensate for productivity changes so that productivity remains stable over time when total inputs and outputs are investigated.

The ability to improve transit performance relies to a great extent on the ability to measure it. This need for performance measures has led to the development of a large number of ad hoc productivity, efficiency, and effectiveness measures. A measure of productivity is suggested that (a) is derived from economic theory, and (b) consistently traces changes in productivity (which includes all the relevant inputs and outputs). The method is total factor productivity and its application in this paper is based on the cost function approach and not the production function approach, which assumes constant returns to scale.

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## REVIEW OF LITERATURE

Among the pioneering work in transit performance analysis is Tomazinis's research, which specifies a set of indicators to be used in measuring partial productivity and efficiency (1). Following Tomazinis, a number of studies have been conducted, all of which attempt to offer explanations for productivity changes and suggestions for productivity improvement. Meyer and Gomez-Ibanez after a detailed analysis of productivity changes in transit systems, suggest elimination of parking, discontinuation of less productive services, and specialization of service as possible approaches to improve productivity (2). In addition to explaining productivity changes, other research has focused on developing relationships between productivity and policy variables. For example, weak statistical relationship has been found between organizational structure and transit performance (3).

These relationships between productivity measures and policy variables are more meaningful if a single measure of productivity can be developed. Although Stokes contends that no one indicator of transit performance (partial productivity) will reveal the relative or absolute performance of a system's management (4), recent research indicates that total factor productivity, defined as total output per unit of total resources expended, is the single best measure of productive efficiency (5). Two approaches can be used to measure total factor productivity: the first utilizes the production function and the second is based on the cost function. The cost function approach is the dual of the production function approach. In both cases, the rate of growth of output, which is unexplained by input growth, is the technical change or productivity. This method of analyzing productivity has been used to calculate and determine the sources of total factor productivity growth for U.S. railroad systems (5).

Concerning measurement of total factor productivity in transit systems, little research exists in this area except that of Meyer and Gomez-Ibanez (2). The absence of research in the application of the total factor productivity method to transit systems makes this current research timely and useful.

## METHODOLOGICAL FRAMEWORK

The derivation of the total factor productivity formula begins by assuming that the production of transit services requires the least-cost combination of the various inputs. Thus if the transit inputs are fuel, labor, vehicles, and materials, the transit manager must select combinations of these inputs to produce a given level of output at least cost. If the exact form of the production function is known, the underlying cost function can be derived. The resulting cost function can be used to calculate total factor productivity. The cost function, as noted earlier, will be the dual of the production function. Thus, total factor productivity can be determined from either the production or cost function. However, a major disadvantage in the production function approach is that it assumes constant returns to scale and, as a result, recent trends indicate that the cost function approach is the most appropriate method to use.

Caves, Christensen, and Swanson (5) have demonstrated that the index of total factor productivity based on a homogeneous, concave, and nondecreasing cost function is given by

$$-(\partial \ln g/\partial T) = \sum^{j} (\partial \ln g/\partial \ln Y_j) \cdot (\partial \ln Y_i/\partial T) - \sum^{i} S_i \, (\partial \ln X_i/\partial T) \qquad (1)$$

where

$g$ = cost function,
$T$ = time,
$Y_j$ = output j,
$S_i$ = cost share of input, and
$X_i$ = input i.

Thus, total factor productivity is the difference between the weighted growth of output and the weighted growth of inputs. Total factor productivity defined in Equation 1 is for marginal changes in the outputs and inputs only. For discrete changes, an approximation to Equation 1 is used. The difference in natural logarithms is used to approximate the logarithmic derivatives, and the arithmetic average of the weights at the beginning and end of a period is used to approximate the instantaneous weights. Thus, total factor productivity is

$$-(\ln g_T - \ln g_{T-1}) = \sum^{j} \{1/2\,[\partial \ln g/\partial \ln Y_j]_T + 1/2\,[\partial \ln g/\partial \ln Y_j]_{T-1}\}\,\{\ln Y_{j,T} - \ln Y_{j,T-1}\} - \sum^{i} \{1/2\, S_{iT} + 1/2\, S_{i,T-1}\}\,\{\ln X_{i,T} - \ln X_{i,T-1}\} \qquad (2)$$

All of the variables in Equation 2 are observable except for the cost elasticities ($\partial \ln g/\partial \ln Y_j$), which must be obtained by using statistical estimation methods. If the cost elasticity is greater (less) than one, there are diseconomies (economies) of scale, whereas a value equal to one indicates constant returns to scale.

To estimate the cost elasticity with respect to output, a modified Cobb-Douglas cost function in which the elasticity of output is variable is specified and used. This is essential to the current analysis, which requires the cost elasticity with respect to output to vary from year to year. Although other functions such as the generalized Leontief, generalized quadratic, or the translog model could have been used, the modified Cobb-Douglas is flexible enough to permit tests of economies of scale for the entire period. To derive this cost function, it is assumed that the production function underlying the cost equation is the Zellnar-Revankar type. That is,

$$Y^{\alpha_Y} \exp\{\alpha_{YY}\,[(\ln Y)^2/2]\} = L^{\alpha_L} K^{\alpha_K} F^{\alpha_F} \qquad (3)$$

where the exponent is the base of natural logarithm and F, L, and K are the quantities of fuel, labor, and vehicles, respectively, and $\alpha_Y$, $\alpha_{YY}$, $\alpha_L$, $\alpha_K$, and $\alpha_F$ are the parameters of the production function equation. Minimizing the cost equation $C = P_F \cdot F + P_L \cdot L + P_K \cdot K$, where $P_F$, $P_L$, $P_K$ are the prices of fuel, labor, and capital, subject to the production function Equation 4 and taking the natural logarithm gives

$$\ln C = B + \theta(\alpha_L \ln P_L + \alpha_K \ln P_K + \alpha_F \ln f) + \alpha_Y \ln Y + 0.5\alpha_{YY}(\ln Y)^2 \qquad (4)$$

where B is the constant term in the cost equation when it is estimated.

Equation 5 is homogeneous of degree plus one in input prices, implying that the coefficients of the input prices sum to one. That is, $\theta(\alpha_L + \alpha_K + \alpha_F) = 1$. This is a restriction that must be imposed on the cost function if it is to be estimated and holds true even in the absence of homogeneity because the price coefficients are also input cost shares. The cost elasticity with respect to output from Equation 4 is given by

$$\partial \ln C/\partial \ln Y = \theta(\alpha_Y + \alpha_{YY} \ln Y) \qquad (5)$$

The results of applying Equation 5 are substituted into Equation 2 along with values for all Y, $S_j$, and $X_i$ to calculate estimates of productivity over a period of time and to compare total productivity growth for a cross section of transit agencies. Although the advantages of this method have already been pointed out, it is appropriate to emphasize its flexibility and methodological superiority as the overriding factors in using it.

It is also possible to use Equation 2 to analyze productivity growth of each factor. For example, holding the quantities of all inputs except one constant at their mean levels allows changes in productivity to be attributed to the input whose quantity is variable. In this paper, such an approach is adopted to determine productivity growth for each factor.

## DATA

The total factor productivity approach was applied to urban transit by analyzing relevant measures for major transit agencies. Secondary data were selected for the past 26 years for the 25 largest agencies that consistently recorded required information during that period.

Two major sources of secondary data have been identified: the Annual Operating Reports for Motor Bus Operations by American Public Transit Association (APTA) (6) and the Section 15 data summary published by UMTA, U.S. Department of Transportation (7).

Although a thorough review of the validity of the APTA data was not found, discussion with UMTA personnel and other university researchers revealed serious problems with the Section 15 data. Problems were found with definitions and reporting of data, particularly related to system evaluation and outputs. Definitional problems were reported for outputs such as capacity miles and passenger miles. Financial measures that are collected routinely for other purposes were found to be most reliable.

The original measures considered were the following:

| | |
|---|---|
| Output: | Number of vehicle miles |
| | Number of passenger trips (unlinked) |
| Input: | Labor operating cost (salaries and wages) |
| | Fuel price (gasoline, diesel, oil, and propane) |
| | Number of vehicles (substitute for capital expenditures) |
| Cost: | This is not adjusted for inflation because only cost shares are used, as discussed. |

Another problem was to find a consistent data set for the entire 26-year period. Transit systems were reviewed for consistent reporting both in APTA and UMTA. Only systems with at most 3 years missing were accepted. A total of 71 systems were identified, which had more than 25 vehicles and which reported regularly.

Of the qualifying systems, it was determined that a minimum of 25 systems was needed to accommodate the degrees-of-freedom requirement of the cost model in a cross-sectional analysis. Table 1 gives a list of these systems.

Subsequent analysis identified data missing on the key variables used in the productivity analysis for some of these systems. A total of 20 systems were ultimately analyzed.

## ESTIMATION OF COST FUNCTION

Appropriate measures of the variables over the analysis period having been obtained, Equation 4 was

**TABLE 1 Qualifying Agencies and Years Reporting**

| System No. | Agency Name | Years Missing | Inclusion in Final Analysis |
|---|---|---|---|
| 1 | Kanawha Valley Regional Transportation Authority, Charleston, W. Va. | 0 | Yes |
| 2 | Savannah Transit Authority, Ga. | 1 | Yes |
| 3 | Charlotte City Transit System, N.C. | 2 | Yes |
| 4 | Southeastern Pennsylvania Transportation Authority, Philadelphia | 2 | No |
| 5 | City Transit Service, Fort Worth, Tex. | 3 | No |
| 6 | Greater Cleveland Regional Transit Authority, Ohio | 3 | No |
| 7 | New Orleans Public Service, Inc., La. | 3 | Yes |
| 8 | New York City Transit System, N.Y. | 4 | Yes |
| 9 | San Diego Transit Corporation, Calif. | 4 | No |
| 10 | Lehigh and North Hampton System, Allentown, Pa. | 4 | Yes |
| 11 | Baltimore Mass Transit Administration, Md. | 4 | Yes |
| 12 | Jacksonville Transportation Authority, Fla. | 4 | Yes |
| 13 | Sun-Tran, Albuquerque, N. Mex. | 4 | No |
| 14 | Southwestern Ohio Regional Transit Authority, Cincinnati | 4 | Yes |
| 15 | Chicago Transit Authority, Ill. | 4 | No |
| 16 | Grand Rapids Transit Authority, Mich. | 5 | No |
| 17 | Central Ohio Transit Authority, Columbus, | 5 | Yes |
| 18 | Niagara Frontier Transit System, Inc., Buffalo, N.Y. | 5 | Yes |
| 19 | Southeastern Transit Authority, Detroit, Mich. | | No |
| 20 | Springfield City Utilities, Missouri | 5 | Yes |
| 21 | C.N.Y. Centro Inc., Syracuse, N.Y. | 5 | Yes |
| 22 | Metro Regional Transit Authority, Akron, Ohio | 5 | Yes |
| 23 | Memphis Area Transit Authority, Tenn. | 6 | Yes |
| 24 | Capital Area Transit Authority, Harrisburg, Pa. | 6 | Yes |
| 25 | Sacramento Regional Transit Authority, Calif. | 6 | Yes |

estimated by using constrained least-squares methods. The first restriction imposed on this equation is the nonnegativity of the price coefficients. Each price coefficient measures the share of cost and hence cannot be negative. Furthermore, the shares cannot be zero because it is assumed that transit managers choose fuel, labor, and capital to produce a given level of output.

The price coefficients were restricted such that they fell within the observed ranges of the cost shares of the various inputs. Thus, the restriction $a_i < B < b_i$ was imposed, where $a_i$ and $b_i$ are the lowest and highest shares of cost of Input i, respectively. This restriction ensures that the cost equation is continuous and nondecreasing in input prices. The second type of constraint imposed is the homogeneity restriction, which ensures that the sum of the price coefficients is one.

A three-step approach was adopted in estimating the coefficients. The first step involved least-squares estimates of the coefficients without any restrictions. Next, the inequality constraints were imposed on the coefficients by using the mixed estimation method discussed by Kmenta (8). The final step in the estimation process involved imposing the linear homogeneity restriction on the coefficients.

The validity of the estimated parameters can be tested by conducting comparative statics on the coefficients. A well-behaved cost function must have positive price coefficients. Because of the sequential method of imposing the constraints, this constraint may be violated in certain cases. In cases when this occurs, the affected system is eliminated from the sample.

Another property of the cost function is that marginal cost should be continuous in output. That is, the marginal cost cannot be negative. Again, it is possible that in rare cases this constraint may be violated. When the coefficients of the linear and quadratic output terms interchange signs, a possibility exists for marginal cost to be negative. For example, if the coefficient of the linear output term is small and positive and the coefficient of the quadratic output term is large and negative, the cost function will not be well behaved and a negative marginal cost will be obtained, a result that is inconsistent with theory. A system exhibiting this characteristic is also eliminated from the sample. Thus, the number of transit systems is further reduced when these results are obtained.

The results of the estimation led to the elimination of six systems from the sample when vehicle miles is used as output and the elimination of five systems when passenger miles is used as output. These systems did not have the appropriate data structure to allow econometric cost functions to be developed. It is possible that a detailed analysis of the data base could pinpoint the sources of inconsistencies in the data structure, but budget and time limitations did not allow further analysis of the data to be performed.

## RESULTS

The results from the estimation process are given in Tables 2 and 3. In these tables, the effects of different sources of data can be observed in Column 8. Of all the systems, only in System 14 did changes in the sources of data have a statistically significant impact on the estimated coefficients. This result indicates that although changes in data sources occurred for all systems, in virtually all systems except one, these changes have an insignificant effect on cost. As a result of this finding, the equation could have been estimated without accounting for changes in data sources.

For each system, more than 95 percent of the variations in costs are explained by variations in input prices and output if vehicle mile is used as output. When passenger mile is used as output the corresponding figure is 89.7 percent. By comparing the equations, a glaring result is that the equations with passenger miles as output can be used to explain a smaller percentage of the variations in cost. Tests of significance of each coefficient in

**TABLE 2 Cost Coefficients**

| System No. | $R^2$ | $\ln P_F$ | $\ln P_L$ | $\ln P_K$ | lnQ | $0.5(\ln Q)^2$ | Data Source |
|---|---|---|---|---|---|---|---|
| 18 | 0.966 | 0.01764 | 0.2798 | 0.70126 | -0.636* | -0.08274 | 0.00656* |
| | | (0.00297) | (0.00911) | (0.00942) | (0.4382) | (0.02694) | (0.0043) |
| 21 | 0.944 | 0.2786 | 0.1166 | 0.6048 | 0.6739 | -0.02144 | -0.0081* |
| | | (0.00624) | (0.0165) | (0.0227) | (0.01887) | (0.00131) | (0.0079) |
| 1 | 0.958 | 0.08279 | 0.5071 | 0.4101 | 0.6494 | 0.0052 | -0.000098* |
| | | (0.00642) | (0.0118) | (0.01675) | (0.01146) | (0.00046) | (0.005789) |
| 22 | 0.986 | 0.1628 | 0.3005 | 0.5367 | 0.7551 | -0.0040 | -0.00251* |
| | | (0.0018) | (0.0033) | (0.0066) | (0.0046) | (0.000053) | (0.00175) |
| 2 | 0.986 | 0.1143 | 0.3974 | 0.4883 | 0.7638 | -0.01429 | -0.00217* |
| | | (0.00204) | (0.0047) | (0.00712) | (0.00508) | (0.00027) | (0.00169) |
| 3 | 0.967 | 0.0843 | 0.6088 | 0.307 | 0.7372 | -0.0172 | 0.000316* |
| | | (0.00285) | (0.00732) | (0.00777) | (0.00615) | (0.00074) | (0.00559) |
| 7 | 0.971 | 0.1073 | 0.6875 | 0.2052 | 0.7799 | -0.00331 | 0.00366* |
| | | (0.00276) | (0.00717) | (0.00602) | (0.00739) | (0.00044) | (0.00379) |
| 12 | 0.986 | 0.1077 | 0.3321 | 0.5602 | 0.7063 | 0.00020 | -0.00076* |
| | | (0.00177) | (0.00446) | (0.00651) | (0.00468) | (0.000032) | (0.00219) |
| 24 | 0.981 | 0.0777 | 0.4405 | 0.4818 | 0.6584 | 0.0066 | 0.000903* |
| | | (0.00266) | (0.00702) | (0.00955) | (0.00544) | (0.00021) | (0.00355) |
| 10 | 0.974 | 0.6193 | 0.3342 | 0.6039 | 0.57 | 0.00608 | 0.00132* |
| | | (0.00353) | (0.01058) | (0.01397) | (0.0084) | (0.00028) | (0.00531) |
| 11 | 0.956 | 0.02213 | 0.3999 | 0.5779 | 0.6582 | -0.01277 | 0.00539* |
| | | (0.00292) | (0.0092) | (0.00985) | (0.00928) | (0.00042) | (0.00723) |
| 14 | 0.951 | 0.03378 | 0.6219 | 0.3444 | 00.8443 | -0.00541 | 0.01323 |
| | | (0.00333) | (0.0092) | (0.00985) | (0.00928) | (0.00042) | (0.00512) |
| 23 | 0.989 | 0.03614 | 0.3047 | 0.6592 | 0.7085 | -0.0067 | 0.000732* |
| | | (0.00139) | (0.00429) | (0.00506) | (0.00327) | (0.00013) | (0.00171)* |
| 20 | 0.971 | 0.2553 | 0.7068 | 0.03791 | 0.6936 | 0.00571 | -0.00196 |
| | | (0.0019) | (0.0059) | (0.0051) | (0.0074) | (0.00027) | (0.0028) |

Note: The standard error is shown in parenthesis under each coefficient. The t-values can be obtained by dividing each coefficient by its standard error. Data source is a dummy variable indicating APTA data or UMTA Section 15 data as the source. In the last column, asterisks represent those data sources that are statistically significant.

**TABLE 3 Coefficient of Cost Equation with Passenger-Miles as Output**

| System No. | $R^2$ | $\ln P_f$ | $\ln P_L$ | $\ln P_K$ | $\ln Y$ | $0.5(\ln Y)^2$ | Data Source |
|---|---|---|---|---|---|---|---|
| 18 | 0.9292 | 0.002404 | 0.3592 | 0.6384 | -0.36 | 0.2528 | 0.009255 |
| | | (0.005195) | (0.01869) | (0.01705) | (0.6176) | (0.0353) | (0.007044) |
| 21 | 0.9549 | 0.2493 | 0.3936 | 0.3571 | 0.6068 | -0.000364 | -0.008542 |
| | | (0.00315) | (0.00892) | (0.00887) | (0.00641) | (0.00031) | (0.00372) |
| 1 | 0.9507 | 0.5996 | 0.5648 | 0.3752 | 0.5028 | 0.007201 | 0.001436 |
| | | (0.00617) | (0.01343) | (0.01628) | (0.00909) | (0.00035) | (0.006522) |
| 22 | 0.9697 | 0.08369 | 0.3362 | 0.5802 | 0.4834 | 0.004633 | -0.003615 |
| | | (0.003313) | (0.00549) | (0.00821) | (0.00493) | (0.000149) | (0.002413) |
| 2 | 0.9281 | 0.184 | 0.4031 | 0.4129 | 0.5599 | -0.00155 | -0.00106 |
| | | (0.00763) | (0.02735) | (0.03388) | (0.01659) | (0.000771) | (0.00833) |
| 3 | 0.9562 | 0.0767 | 0.5581 | 0.3652 | 0.8121 | -0.0119 | 0.00106 |
| | | (0.00419) | (0.01075) | (0.01169) | (0.01013) | (0.000544) | (0.00742) |
| 7 | 0.9647 | 0.1198 | 0.7314 | 0.1488 | 0.6866 | -0.00893 | 0.00117 |
| | | (0.0036) | (0.01075) | (0.00728) | (0.00889) | (0.00031) | (0.00451) |
| 8 | 0.901 | 0.1441 | 0.8332 | 0.02267 | 0.6947 | -0.00915 | 0.00272 |
| | | (0.00888) | (0.02856) | (0.0382) | (0.01917) | (0.00105) | (0.05201) |
| 12 | 0.9561 | 0.1176 | 0.2881 | 0.5943 | 0.5864 | 0.000181 | 0.00105 |
| | | (0.003793) | (0.01189) | (0.01471) | (0.0079) | (0.00009) | (0.006002) |
| 23 | 0.9314 | 0.09264 | 0.2531 | 0.6542 | 0.5297 | 0.00064 | 0.001341 |
| | | (0.006912) | (0.02421) | (0.02581) | (0.01362) | (0.000841) | (0.01804) |
| 24 | 0.9411 | 0.05924 | 0.3125 | 0.6283 | 0.4436 | 0.00526 | 0.000974 |
| | | (0.006353) | (0.02003) | (0.02502) | (0.01491) | (0.000444) | (0.01133) |
| 25 | 0.8965 | 0.599 | 0.1884 | 0.2125 | 0.8584 | -0.03868 | 0.006059 |
| | | (0.00377) | (0.00167) | (0.00367) | (0.00548) | (0.000356) | (0.00467) |
| 10 | 0.9025 | 0.126 | 0.2722 | 0.6018 | 0.5019 | 0.0001223 | 0.001643 |
| | | (0.01134) | (0.04221) | (0.04593) | (0.01999) | (0.000485) | (0.02055) |
| 11 | 0.9054 | 0.04187 | 0.4159 | 0.5422 | 0.5256 | -0.01864 | 0.003753 |
| | | (0.003725) | (0.01055) | (0.00919) | (0.007743) | (0.00049) | (0.00825) |
| 14 | 0.9128 | 0.03095 | 0.6771 | 0.2919 | 0.7633 | -0.001091 | 0.01717 |
| | | (0.00496) | (0.01377) | (0.01491) | (0.0101) | (0.0003871) | (0.007572) |

Note: The standard errors are shown in parentheses. The t-values can be obtained by dividing each coefficient by its standard error.

the cost equation can also be obtained by dividing the standard error shown in parenthesis into each coefficient. The result of this division indicates that, in Table 2, all the estimated coefficients are statistically significant at the 95 percent confidence level except the linear output term in System 18. The same cannot be said of Table 3; some of the coefficients in this table are statistically insignificant.

## INITIAL PRODUCTIVITY

By using the estimated coefficients, total factor productivity was calculated for each of the 26 years and for each of the 14 systems that was determined to have sufficient data for analysis. (The data criterion is discussed in another section of this paper.) Tables 4 and 5 present total factor productivity for System 14 in Cincinnati. The results are typical of those obtained and indicate that little change occurs in total factor productivity. The relative lack of change in total productivity is underscored by the average change for each system given in Table 6. A comparison of means to standard errors indicates that the means are an order of magnitude smaller than the standard error in every case but one. In all cases, they are not significantly different from zero at the 0.05 significance level. This indicates a lack of growth in total factor productivity for the period of the study and is true for both vehicle miles and passenger miles.

To investigate short-term periods of productivity growth, the overall period of the study was divided into approximate 5-year intervals. The results indicated that in virtually all cases, average productivity changes were not significantly different from zero at the 5 percent significance level. This is true for all systems for all time periods.

The consistency from system to system and period to period indicates that national trends and events have had little effect on system productivity. For example, systems were equally productive before and after the introduction of federal operating subsidies during the period from 1970 to 1975. It could be hypothesized that such changes would be negative as a result of passive supervision of subsidy programs and the influx of large amounts of additional monies. However, this is not the case. Each year there is a mixture of productivity gains and losses all of which are not significantly different from zero. The same trends occurred during the periods of the fuel crises (1973 and 1978). Apparently, the changes in demand for service were compensated for by changes in cost.

**TABLE 4 Performance of Cincinnati System Calculated Using Vehicle-Miles**

| Year | Total Factor Productivity | Labor Productivity | Capital Productivity | Fuel Productivity |
|---|---|---|---|---|
| 1956 | -0.0026 | 0.0242 | 0.0178 | 0.0364 |
| 1957 | 0.0276 | 0.0575 | 0.0171 | 0.0386 |
| 1958 | 0.0155 | 0.0476 | 0.0264 | 0.0480 |
| 1959 | 0.0126 | 0.0230 | 0.0176 | 0.0257 |
| 1960 | -0.0002 | 0.0134 | 0.0055 | 0.0155 |
| 1961 | 0.0052 | -0.0695 | 0.0046 | -0.0610 |
| 1962 | -0.0274 | -0.1042 | -0.0282 | -0.0954 |
| 1963 | 0.0043 | -0.0132 | 0.0074 | -0.0080 |
| 1964 | 0.0268 | 0.0127 | 0.0320 | 0.0147 |
| 1965 | 0.0494 | -0.0071 | 0.0508 | -0.0014 |
| 1966 | -0.0428 | -0.0378 | -0.0385 | -0.0332 |
| 1967 | 0.1352 | 0.1520 | 0.1228 | 0.1304 |
| 1968 | -0.0952 | -0.0492 | -0.0760 | -0.0262 |
| 1969 | -0.0071 | 0.0114 | 0.0096 | 0.0278 |
| 1970 | -0.0250 | -0.0221 | -0.0177 | -0.0130 |
| 1971 | 0.0393 | 0.0509 | 0.0544 | 0.0544 |
| 1972 | -0.1205 | 0.0252 | -0.0637 | 0.0782 |
| 1973 | 0.1070 | 0.0305 | 0.0983 | 0.0201 |
| 1974 | 0.0311 | -0.0614 | -0.0252 | -0.1006 |
| 1975 | -0.0303 | -0.0278 | -0.0701 | -0.0546 |
| 1976 | 0.0644 | -0.0437 | 0.0359 | -0.0572 |
| 1977 | 0.0182 | 0.0311 | 0.0105 | 0.1065 |
| 1978 | -0.2464 | -0.1313 | -0.1089 | 0.0151 |
| 1979 | 0.0276 | 0.0077 | 0.0217 | -0.0194 |
| 1980 | -0.0277 | 0.0112 | -0.0340 | 0.0042 |
| 1981 | -0.0151 | -0.0065 | -0.0072 | -0.0075 |

**TABLE 5 Performance of Cincinnati System Calculated Using Passenger-Miles**

| Year | Total Factor Productivity | Labor Productivity | Capital Productivity | Fuel Productivity |
|---|---|---|---|---|
| 1956 | -0.38 | 0.15 | -0.16 | 0.23 |
| 1957 | -0.02 | 0.004 | -0.002 | 0.02 |
| 1958 | -0.007 | 0.04 | -0.004 | -0.02 |
| 1959 | -0.01 | 0.02 | -0.002 | 0.02 |
| 1960 | -0.02 | -0.01 | -0.02 | -0.008 |
| 1961 | -0.06 | -0.05 | -0.05 | -0.04 |
| 1962 | 0.08 | 0.007 | -0.08 | 0.02 |
| 1963 | 0.08 | -0.03 | 0.05 | -0.02 |
| 1964 | 0.007 | -0.01 | 0.01 | -0.005 |
| 1965 | 0.02 | 0.07 | 0.03 | 0.01 |
| 1966 | 0.05 | -0.01 | 0.05 | -0.004 |
| 1967 | -0.01 | -0.007 | -0.007 | -0.002 |
| 1968 | -0.05 | 0.07 | 0.04 | 0.04 |
| 1969 | -0.09 | -0.04 | -0.07 | -0.02 |
| 1970 | -0.03 | -0.007 | -0.009 | 0.01 |
| 1971 | -0.02 | -0.02 | -0.01 | -0.01 |
| 1972 | -0.08 | 0.08 | 0.09 | 0.01 |
| 1973 | -0.19 | -0.05 | -0.14 | 0.0007 |
| 1974 | 0.103 | 0.03 | 0.04 | 0.02 |
| 1975 | 0.01 | -0.02 | 0.02 | -0.06 |
| 1976 | 0.01 | 0.01 | -0.03 | -0.01 |
| 1977 | -0.12 | -0.002 | -0.08 | -0.02 |
| 1978 | -0.02 | -0.005 | -0.03 | -0.02 |
| 1979 | 0.26 | -0.15 | -0.113 | -0.008 |
| 1980 | -0.05 | 0.01 | 0.04 | 0.003 |
| 1981 | -0.07 | -0.03 | -0.07 | 1.103 |

**TABLE 6 Average Change in Total Factor Productivity for All Systems**

| System No. | Vehicle Miles Avg Change | Vehicle Miles Standard Error | Passenger Miles Avg Change | Passenger Miles Standard Error |
|---|---|---|---|---|
| 1 | -0.005 | 0.015 | 0.0168 | 0.064 |
| 2 | -0.009 | 0.012 | -0.0003 | 0.092 |
| 3 | 0.002 | 0.014 | 0.003 | 0.873 |
| 7 | 0.007 | 0.189 | -0.006 | 0.083 |
| 10 | -0.003 | 0.221 | -[a] | -[a] |
| 11 | 0.000 | 0.124 | 0.086 | 0.426 |
| 12 | -0.002 | 0.131 | -0.012 | 0.110 |
| 14 | -0.003 | 0.142 | -0.020 | 0.113 |
| 18 | -0.013 | 0.011 | -0.012 | 0.055 |
| 20 | -0.002 | 0.036 | 0.146 | 0.029 |
| 21 | 0.007 | 0.038 | 0.026 | 0.165 |
| 22 | -0.020 | 0.116 | -0.016 | 0.476 |
| 23 | -0.023 | 0.014 | -0.014 | 0.175 |
| 24 | -0.003 | 0.013 | -0.022 | 0.114 |

Note: Agencies corresponding to system numbers are given in Table 1.
[a]Insufficient data.

Another alternative hypothesis was that productivity has been declining because of reduced demand for public transport. However, these measures indicate that reduced demand has been met by reduced service level in a way that results in little change in productivity over an extended period of time. Thus, these systems have responded to alternate pressures to provide service and do so efficiently.

Finally, it must be noted that there was no significant effect of changes in reporting on costs during the period from 1978 to 1981 when the new Section 15 data were utilized. Further, isolated examination of trends during 3 selected years when major national trends had an impact on transit (1973, 1974, and 1978) reveal no trends, either positive or negative. Only during 1978 did the majority of systems show a decrease in productivity. This could indicate a reduction in productivity during a brief, highly inflationary period. However, the trend is not true for systems in Springfield, Missouri (System 20), and Akron, Ohio (System 22). Further, these results are confounded by the change in data sources at that time.

In sum, the results of the total factor productivity analysis indicate that systems tend to adjust and compensate, keeping inputs and outputs in balance in the long run for both dependent variables. For example, there is a compensatory process occurring in which capital, labor, and fuel productivity are substituted alternately, thus creating an overall balance over time. This process is evidenced by the average changes in total factor and partial productivity that are given in Table 6. Furthermore, the data in Table 7 indicate that total factor productivity has decreased on average; this is compensated for by increases in average productivity of capital and fuel. However, these changes are small and are not significantly different from zero at the 5 percent level. This pattern of negative total factor productivity and labor productivity but positive capital and fuel productivity is experienced by four systems (1, 14, 18, and 22). The other systems indicate other compensating patterns. One interesting pattern is demonstrated in Memphis, Tennessee (System 23). There, the negative growth in total productivity is the result of positive partial contributions, which is the result of the definitions of productivity with inputs combining to overcome the contribution of the output to productivity growth.

## Detailed Analysis of Productivity

A detailed analysis of productivity was performed on two systems for 3 separate years (1956, 1974, and 1981). These 3 years were chosen because of the following reasons. First, the beginning and ending periods in the data set are 1956 and 1981. Second, in 1974, a major event--the introduction of federal operating subsidy under Section 5 of the Urban Mass Transportation Act--was having an impact on transit. Also, because the two transit systems, Charleston, West Virginia, and Charlotte, North Carolina, indicated patterns typical of the results obtained for all the transit systems analyzed, they were singled out for detailed analysis.

### Productivity for Charleston, West Virginia

In 1956, there was an overall increase in productivity. In 1974, the year of increased subsidies, productivity decreased in all categories. In 1981, an overall increase was once again observed. Of interest is the across-the-board pattern observed in each of these years.

### Productivity in Charlotte, North Carolina

In contrast to Charleston, Charlotte indicates a pattern of compensation. In 1956, there was an across-the-board decrease in productivity but in 1974 a decrease in capital productivity was compensated for by increases in labor and fuel productivity. In 1981, a decrease in labor productivity was compensated for by increases in the productivities of the other inputs.

## Patterns of Increases and Decreases

The question of similarities of increases and decreases in productivity between partial and total factor productivity was investigated by calculating correlations between increases and decreases in each measure for each system. Two patterns were identified. The first pattern is a compensatory pattern in

**TABLE 7 Total Factor and Partial Productivity**

| System No. | Agency Name | Total Factor | Labor | Partial Capital | Fuel |
|---|---|---|---|---|---|
| 1 | Kanawha Valley Regional Transportation Authority | -0.005 | -0.002 | 0.000 | 0.005 |
| 2 | Savannah Transit Authority | -0.010 | -0.001 | -0.002 | 0.007 |
| 3 | Charlotte City Transit System | -0.005 | -0.009 | -0.004 | -0.003 |
| 7 | New Orleans Public Service, Inc. | 0.002 | -0.005 | 0.004 | -0.003 |
| 10 | Lehigh and North Hampton System | -0.003 | 0.014 | 0.015 | 0.029 |
| 11 | Baltimore Mass Transit Administration | 0.000 | -0.001 | -0.002 | -0.002 |
| 12 | Jacksonville Transportation Authority | -0.002 | -0.007 | -0.006 | -0.004 |
| 14 | Southwestern Ohio Regional Transit Authority | -0.013 | -0.001 | 0.002 | 0.002 |
| 18 | Niagara Frontier Transit System, Inc. | -0.013 | -0.001 | 0.005 | 0.017 |
| 20 | Springfield City Utilities | -0.002 | 0.0035 | 0.007 | 0.010 |
| 21 | C.N.Y. Centro, Inc. | -0.004 | 0.004 | 0.007 | 0.006 |
| 22 | Metro Regional Transit Authority | -0.019 | -0.009 | 0.003 | 0.012 |
| 23 | Memphis Area Transit Authority | -0.023 | -0.019 | -0.015 | -0.009 |
| 24 | Capital Area Transit Authority | -0.003 | 0.008 | 0.013 | 0.022 |
| Average total | | -0.007 | -0.002 | 0.002 | 0.006 |

which capital productivity was compensated for by labor and fuel productivity changes. Systems 2, 3, 14, and 24 exhibited this pattern. The correlation matrix of this pattern is exhibited by System 2 (Savannah, Georgia). (* = significant at the 5 percent level.)

| | Total Factor | Labor | Capital | Fuel |
|---|---|---|---|---|
| Total factor | 1.0 | 0.51* | 0.82* | 0.10 |
| Labor | | 1.0 | 0.36* | 0.80* |
| Capital | | | 1.0* | 0.29 |
| Fuel | | | | 1.0 |

From this table it can be observed that capital and total factor productivity are highly correlated as are labor and fuel. This point is better illustrated by a principal components analysis. The factor scores for an analysis of these data are given in the following table.

| Productivity Measure | Factor 1 | Factor 2 |
|---|---|---|
| Total factor | 0.55 | -0.12 |
| Labor | 0.02 | 0.49 |
| Capital | 0.51 | -0.08 |
| Fuel | -0.19 | 0.61 |

By using the criterion of the eigenvalue greater than 1, this is a two-factor solution. The first factor accounts for 62 percent of the variance and is most closely related to total factor and capital productivity. Factor 2 accounts for 30 percent of the variance and is most closely related to labor and fuel productivity. This factor is therefore labeled operating resources. These factors are unrelated (orthogonal) and the measures indicate that for this agency capital decisions and operating decisions are not related. Compensatory activities therefore occur, for the most part, within factors over time. The other systems in this group behave similarly.

The other group indicates a high degree of across-the-board increases or decreases in productivity. In this case, all variables increase or decrease at the same time and compensation takes place year by year instead of within years. Systems that behave in this way are Systems 1, 10, 11, 12, 18, 20, and 22. System 22 is typical of this group and the correlations for partial and total factor productivity are given in the following table.

| | Total Factor | Labor | Capital | Fuel |
|---|---|---|---|---|
| Total factor | 1.00 | 0.995 | 0.992 | 0.982 |
| Labor | | 1.00 | 0.996 | 0.994 |
| Capital | | | 1.00 | 0.996 |
| Fuel | | | | 1.00 |

All coefficients are significant at the 5 percent level. All measures are highly correlated, and a principal components analysis reveals that they represent one overall productivity factor. Compensation therefore occurs within the overall factor over time.

Two systems (7 and 21) were unique in their patterns. No system characteristics were found that adequately explained these variations.

## Similarities Between Systems

Finally, the similarity between increases and decreases in total factor productivity between systems was investigated. Initial analyses using analysis of variance resulted in no significant differences in changes between systems because they were all not significantly different from zero. Instead, by using vehicle miles as the output measure, systems whose productivity measures were highly correlated were grouped together.

By using principal components analysis and a criterion of an eigenvalue greater than one, seven factors were obtained. Further, by using only factor scores with significant correlations between factors and systems, no consistent pattern emerges. At most, three systems correlate highly with any single factor. Factors 1, 4, and 7 are related to System 18 (Buffalo, New York), System 19 (Detroit, Michigan), and System 1 (Kanawha Valley, Ohio), respectively. The systems related to Factor 2 are 20 (Springfield, Missouri), 22 (Akron, Ohio), and 24 (Harrisburg, Pennsylvania). Factor 3 is related to Systems 10 (Allentown, Pennsylvania) and 22 (Akron, Ohio). Factor 5 is related to Systems 12 (Jacksonville, Florida) and 14 (Cincinnati, Ohio). Factor 6 is related to Systems 11 (Baltimore, Maryland) and 23 (Memphis, Tennessee).

Although these indicators do not contain sufficiently detailed information to describe the mechanisms by which compensatory activities occur, it might be possible to find predictors of productivity changes. Because the systems for the most part have orthogonal changes in productivity, one is led to the conclusion that no such predictors exist. For the few agencies that do cluster together, there appears to be little in common. The predictors that were considered were size, density, geographical region, and degree of state subsidy contribution. Only Factor 3 appears to have a relationship in size, geographical location, and state assistance; however, other similar systems (e.g., Allentown, Pennsylvania) do not cluster there. In short, of the predictors considered, there are no clear predictors of cluster membership and thus of changes in total factor productivity.

## CONCLUDING REMARKS

There are two overriding conclusions from this study. First, the total cost function approach applied provides a close fit to public transit cost data. The second conclusion is that the change in total factor productivity over time is not substantial.

These conclusions have implications for management and policy issues; they lead to the further conclusion that management decisions have over time resulted in little change in the level of productivity. This can be observed by using both vehicle miles and passenger miles as output measures. The indicators developed here demonstrate a compensatory effect within partial factors over time. However, the data available to this study are not sufficient to describe and test hypotheses about the causes and effects.

It is also observed that the results of this analysis contradict those of previous research that examines partial productivity. Those results have indicated an overall trend toward decreasing productivity. On the other hand, Meyer and Gomez-Ibanez found a contradiction for both partial and total measures of productivity when revenue passenger was the output measure (decreasing productivity) and when vehicle miles was the output measure (increasing productivity).

In the case of partial measures, the contradiction between the results of this study and those of previous efforts is due to the approach of this paper, which considers all inputs, whereas those based on partial productivity do not. Also in the current study, both total and partial measure take into account (dis)economies of scale. Further, the partial measures are determined by holding the other inputs at their mean levels. In other words, the indicators utilized in this study account for changes in productivity that result solely from changes in specified inputs. For total factor productivity, changes in the complete set of inputs (labor, capital, and fuel) are used. This unique modeling approach also accounts for the differences between the Meyer and Gomez-Ibanez results, which do not account for (dis)economies of scale, and the results of this study.

Future research will examine the root causes (i.e., geographic, organizational, contractual) and their influence on productivity in the hope of developing guidelines for planning and management decisions.

## ACKNOWLEDGMENT

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# Coordination of Transportation Resources: The Georgia Experience

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ABSTRACT

Coordination of public transportation services has been discussed by government administrators for years. It is increasingly apparent that the problems of mobility are not necessarily linked to a lack of vehicles or operating resources. Rather, it may be that more can be done with what is available to alleviate problems of mobility. Examined is the difference between coordinated and noncoordinated transportation systems. By using select counties in Georgia, the transportation services within the counties are reviewed and measured against state operating policy. Although the results must be considered tentative because of incomplete information from operations in noncoordinated counties, the clear indication is that coordinated systems make better use of resources and provide more economic and cost-effective transportation service.

Georgia, the largest state east of the Mississippi River, has a land area of 58,876 mi² and consists of 159 counties. The 1980 population was 5.5 million, of which 48 percent resided in the 10 urbanized areas and the other 52 percent lived in nonurbanized regions. The diversity between urbanized areas and nonurbanized areas is striking mostly because of the low population density of nonurbanized areas.

Georgia's geography is also diverse. Land formations vary greatly so that while the Appalachian Mountains in the north provide skiing in the winter, the Golden Islands to the south attract sunbathers all year long. This diverse topography combines with low-density development to provide a challenge for rural public transportation operations.

Transportation providers have faced up to the challenge of providing transportation opportunities in areas with diverse topography and population centers of varying sizes. In the past, lacking the availability of public transportation programs, social services have developed transportation programs oriented to agency clients. However, local governments are increasingly becoming aware of the need for public transportation services to address a broader population, and more transportation programs have been developed and implemented.

The benefits of coordination of transportation programs are apparent in rural areas. There are a multitude of publicly financed transportation programs in the rural areas, having purpose and scope so narrowly defined that the areas suffer a lack of mobility, despite the considerable public investment. Coordination of resources in these programs has the potential to alleviate the situation of need in the midst of plenty by putting into operation vehicles that otherwise are available for limited service of an exclusive clientele. The exclusiveness of these services, funded through categorical grants, has fostered a lack of coordination among agencies in an area. These agencies have stand-alone programs that, although publicly funded, are exclusionary in scope of service. Unlike other federal programs administered within the governmental process (e.g., roads, water quality, police), federal social service programs are commonly administered by private nonprofit agencies with largely parochial interests. Local governments have seldom required agencies to pool resources because the funding process has effectively bypassed any opportunity for their involvement. The direct federal-local agency link has removed the federally funded programs (mostly social service programs) from local governmental influence and at the same time from local government participation and support. It is this element of local government participation and support that has made coordinated public transportation programs in Georgia successful.

The Urban Mass Transportation Administration (UMTA) Section 16(b)(2) Program was the first federal initiative that allowed states to implement coordinated specialized public transportation programs. The Georgia Section 16(b)(2) Program took a unique approach to elderly and handicapped services. Recognizing the overabundance of uncoordinated, fragmented, and disorganized transportation programs for the elderly and handicapped already competing in rural areas, the Georgia Department of Transportation (GDOT) turned to the county governments to select a single Section 16(b)(2) recipient for their area. The operator, named through a county resolution, would be the single transportation operator for elderly and handicapped passengers of its own and other agencies.

By selecting a designated agency to provide coordinated elderly and handicapped service, the county assumed a role in the administration and operation of the program. Overall, this has worked to the program's advantage. Because many services are county-sponsored, the designated private, nonprofit operators typically have access to county garages, may purchase fuel at a reduced rate from county pumps, and receive a number of other benefits that would otherwise not be available. The county, in turn, receives the benefit of a broad-based transportation operation.

Because of county involvement in public transportation operations, a broader scope of county interest has developed. Georgia has a number of Section 16(b)(2) programs that have evolved into public transportation (Section 18) programs. If county

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government involvement had not been present, the potential for developing a coordinated public transportation service would have been diminished. The counties' interests lie in (a) what they believe to be a public responsibility to provide mobility services for residents that need them, and (b) the economic impact of this mobility to the local area.

Transportation services help the local economy by funneling the purchasing power to local businesses of those individuals receiving social security income, retirement income, and other public income funds. They also provide access to jobs, medical care, and other community programs. These public transportation services address the collective need for mobility in the county and have become a factor in the economic vitality of the area.

## STUDY AREA

Compared in this paper are two types of public transportation systems currently operating in rural areas of Georgia: coordinated public transportation systems administered by GDOT with fiscal and operational responsibilities vested in the county, and noncoordinated systems administered by social service agencies with fiscal and operations responsibility vested in the social service agency. The social service transportation programs represent activities ancillary to the main function of the social service agency, which is to provide social services to target population groups. The coordinated public transportation systems operate essentially as line functions of county governments and represent an area of public service.

The study included the selection of counties situated throughout Georgia that offered either coordinated or noncoordinated transportation services. A total of 10 rural counties were selected for the analysis, which were equally divided with five of the counties having coordinated transportation (Section 18) programs and five representing noncoordinated (social service programs) transportation. The selection criteria used attempted to balance the selection of counties geographically so that each group would have a mixture of topography. In the five counties that had coordinated programs, noncoordinated services were also available. However, it was believed that because the coordinated transportation programs were the dominant service in the area, it would not affect the results. In the counties with noncoordinated transportation service, there was no coordinated [Section 16(b)(2) or Section 18] transportation available. Both study groups have a predominant rural character with comparable density (66 coordinated group versus 61 noncoordinated group per $mi^2$) and comparable topography.

Tables 1 and 2 present information that describes dominant features of the two groups. A detailed analysis was made of each county's program by comparing various performance indicators (see Tables 3 and 4). Figure 1 shows a map containing the study counties.

**TABLE 1 Public Transportation Programs (coordinated)**

| County | Topography | Population 1980 | 1980 Land Area ($mi^2$) | No. of Operators | No. of Vehicles |
|---|---|---|---|---|---|
| Berrien | Flat | 13,525 | 456 | 1 | 1 |
| Clay | Flat | 3,553 | 197 | 1 | 1 |
| Forsyth | Mountainous | 27,958 | 226 | 1 | 1 |
| Greene | Rolling hills | 11,391 | 390 | 1 | 2 |
| Walker | Mountainous | 56,470 | 446 | 1 | 5 |

**TABLE 2 Social Service Programs (noncoordinated)**

| County | Topography | Population 1980 | 1980 Land Area ($mi^2$) | No. of Operators | No. of Vehicles |
|---|---|---|---|---|---|
| Baker | Flat | 3,808 | 347 | 3 | 7 |
| Coweta | Rolling hills | 39,268 | 447 | 4 | 12 |
| Emanuel | Rolling hills | 20,795 | 688 | 6 | 18 |
| Lowndes | Flat | 67,972 | 507 | 3 | 22 |
| Meriwether | Rolling hills | 21,229 | 506 | 5 | 23 |

## ANALYSIS

To compare the relative benefits of coordinated public transportation systems and noncoordinated social service transportation programs, it was necessary to access operations information for the selected systems. Historical data were researched and recorded for the two types of transportation systems. The operations information for the coordinated programs came from the Rural Management Information System reports submitted to GDOT by rural public transportation operators on a monthly basis. The most current year's information (fiscal year 1985) was utilized. The type of information derived from this source included number of vehicles, passenger trips, vehicle miles, and days of operations, as well as program costs. Total operating costs included both administrative costs and operating costs charged against each of the programs.

**TABLE 3 Coordinated Public Transportation Programs**

| Performance Indicator | County: Berrien | Clay | Forsyth | Greene | Walker |
|---|---|---|---|---|---|
| No. of operators | 1 | 1 | 1 | 1 | 1 |
| No. of vehicles | 1 | 1 | 2 | 2 | 5 |
| Total no. of vehicle miles | 36,601 | 31,503 | 46,791 | 73,851 | 102,373 |
| No. of annual days of operation | 268 | 262 | 244 | 252 | 275 |
| Total cost ($) | 41,675 | 30,571 | 14,991 | 36,903 | 46,285 |
| No. of passenger trips | 13,856 | 13,039 | 15,684 | 19,353 | 34,820 |
| No. of monthly days of operation | 22 | 22 | 20 | 21 | 23 |
| No. of miles per vehicle | 36,601 | 31,503 | 23,396 | 36,926 | 20,475 |
| Cost per mile ($) | 1.14 | 0.97 | 0.32 | 0.50 | 0.45 |
| Cost per vehicle ($) | 41,675 | 30,571 | 7,496 | 18,452 | 9,257 |
| Cost per trip ($) | 3.01 | 2.34 | 0.96 | 1.91 | 1.33 |
| No. of passengers per mile | 0.38 | 0.41 | 0.34 | 0.26 | 0.34 |
| No. of passengers per vehicle | 13,856 | 13,039 | 7,842 | 9,677 | 6,964 |

Note: Data are from the Georgia Department of Transportation, and are for fiscal year 1985.

**TABLE 4 Noncoordinated Social Service Transportation Programs**

| Performance Indicator | County: Baker | Coweta | Emanuel | Lowndes | Meriwether |
|---|---|---|---|---|---|
| No. of operators | 3 | 4 | 6 | 3 | 5 |
| No. of vehicles | 7 | 12 | 18 | 22 | 23 |
| Total no. of vehicle miles | 39,495 | 115,057 | 184,964 | 249,208 | 387,819 |
| No. of annual days of operation | 102 | 175 | 169 | 146 | 152 |
| Total cost ($) | 28,672 | 78,899 | 76,295 | 145,820 | 164,527 |
| No. of passenger trips | NA | NA | NA | NA | NA |
| No. of monthly days of operation | 9 | 15 | 14 | 12 | 13 |
| No. of miles per vehicle | 5,642 | 9,588 | 10,276 | 11,328 | 16,862 |
| Cost per mile ($) | 0.73 | 0.69 | 0.41 | 0.59 | 0.42 |
| Cost per vehicle ($) | 4,096 | 6,575 | 4,239 | 6,628 | 7,153 |
| Cost per trip | NA | NA | NA | NA | NA |
| No. of passengers per mile | NA | NA | NA | NA | NA |
| No. of passengers per vehicle | NA | NA | NA | NA | NA |

Note: Data are from the Georgia Department of Human Resources, and are for fiscal year 1984. NA = not available.

For comparison, information on the noncoordinated systems was provided by the Georgia Department of Human Resources, which oversees social service programs in Georgia. Summary reports by social service program are required from each of the social service agencies on an annual basis; the most current data available were for fiscal year 1984. A review of the data revealed that information on key areas was missing, such as passenger trips. In addition, discrepancies were noticed in the summaries, particularly in the area of operating costs. Consequently, use of the social service transportation information was limited to number of operating agencies in each county, total vehicles, vehicle miles, and days of operation, as well as total operating cost.

Three different types of analyses were completed. The first type took into consideration service comparisons that contrasted the utilization and availability of transportation services provided by the two types of operations. In the second type of analysis, performance indicators were evaluated, which gave a relative appraisal on how well service was being operated. In the third type of analysis, the service operations were compared with the criteria


**FIGURE 1 Map of coordinated and noncoordinated study counties in Georgia.**

in the GDOT service policy, which serves as a benchmark of operations service levels for public transportation programs.

Service Comparisons

Several key areas were studied to determine the relative advantages of the two types of transportation systems. Level of vehicle utilization and number of vehicle miles were used as measures of service effectiveness. Operating cost was investigated as an indication of service cost efficiency, and condition of vehicles was considered an important marketing tool because reliability of service is important in rural areas.

Vehicle Utilization

The coordinated programs had a higher level of vehicle utilization, as measured in days of service; they operated 244 to 275 days per year, or an average of 20 to 23 days per month. The noncoordinated providers exhibited lower average utilization, ranging between 102 and 175 days of service per year, or between 9 and 12 service days per month.

On the average, the coordinated programs had 43 percent higher utilization annually and 42 percent higher utilization monthly than the noncoordinated programs. Number of service days would indicate that there was a corresponding level of service availability, service delivery, and resource utilization. In the coordinated counties, the level of vehicle utilization is in the requirements of the GDOT service policy, which stipulates 240 days annually. The coordinated programs meet this criterion and therefore demonstrate a comparatively higher level of service effectiveness in rural operations.

Vehicle Miles

During fiscal year 1985, the five coordinated operators logged a total of 291,119 vehicle miles of operation with the 11-vehicle fleet. This number represents an annual average of 26,465 miles per vehicle. In fiscal year 1984, the noncoordinated human service programs reported a combined total of 976,543 vehicle miles for the 82-vehicle fleet, for an average of 11,909 miles per vehicle. Coordinated transportation programs provided a level of vehicle miles of service per vehicle that was 122 percent higher than that of noncoordinated programs. This again reflects the findings from the vehicle utilization analysis: coordinated programs have a comparatively higher level of service effectiveness.

Operating Cost

Coordinated transportation providers reported a total system operating cost ranging from $14,991 to $46,285. These costs are based on actual monthly reimbursements and audited figures provided by each of the transportation programs. The reason for the variance in transportation costs from county to county is attributable in part to the type of equipment being operated; van operations are not as expensive as minibus vehicles. The average cost per vehicle for the five-county coordinated region was $15,493.

Transportation costs of the noncoordinated program ranged from $28,672 (a county with 3 agencies and 7 vehicles) to $164,527 (a county with 5 agencies and 23 vehicles). Total operating costs appear low, considering the number of vehicles that are operated by each of the agencies. If all five noncoordinated counties are combined, the average cost per vehicle is $6,027. The transportation costs of the noncoordinated counties appear to fall below the average operating costs for vans nationwide and may not be accurate. The figures for the noncoordinated programs are not audited and are collected annually from the social service providers.

Insurance Cost

An area of importance to any transportation operator, and one that significantly affects operating costs, is insurance. Section 45-9-42 of the Official Code of Georgia, Annotated, allows all private, nonprofit agencies that contract with the state Department of Human Resources to carry insurance provided under a state policy. In 1985 for vans costing approximately $13,500, the vehicle insurance cost was $307.00 per year with a $250.00 deductible. One stipulation is that the state retain title to the vehicle. For subsequent years, the insurance cost is calculated at a rate of $1.60 per $100.00 value of the vehicle plus $100.00 for liability. This arrangement guarantees a lower insurance cost as the vehicle ages.

The coordinated public transportation providers, on the other hand, purchase insurance coverage from commercial vendors at a significantly higher cost per vehicle. This affects operating cost of the coordinated systems in which the average cost of insurance is $1,200 per vehicle unless the county is successful in securing a fleet rate. It has become more difficult to secure a fleet rate on public transportation vehicles.

Passenger Trips

The five coordinated operators listed totals ranging from 13,039 to 34,820 passenger trips during the study period for an average of 19,350 per county. Passenger trip counts for the noncoordinated transportation providers were not available for comparison.

Condition of Vehicles

Vehicles in the coordinated programs fall under GDOT's vehicle (capital disposition) policy. As a means of maintaining the operations quality and safety performance, the policy establishes guides for vehicle replacement. The condition of vehicles (vans) with 5 years or 100,000 miles is evaluated to determine if replacement or rehabilitation is needed. All vehicles under the coordinated program are inspected quarterly by the GDOT district offices for safety, operability, and mechanical soundness. The condition of brakes, tires, and operation of lights, horn, and windshield wipers are some of the 26 items inspected. Required inspection and a review of scheduled routine service records such as oil change and tune-up are also performed as a part of the quarterly review. Repairs needed are recorded and a follow-up inspection is made to ensure that the vehicles have been repaired and are in safe and proper operating condition. The current coordinated rural public transportation fleet consists of mostly late-year models (see Table 5). The noncoordinated social service transportation fleet is a mixed fleet with 18 percent classified as surplus and backup (see Table 6). Replacement of vehicles is easier in the coordinated programs because these programs have

**TABLE 5 Summary of Coordinated Fleet in the Study Area**

| Year of Model | Type | Number |
|---|---|---|
| 1978 | Minibus | 1 |
| 1979 | Minibus | 1 |
| 1980 | Minibus | 1 |
| 1982 | Van | 2 |
| 1983 | Van | 4 |
| 1985 | Van | 2 |

Note: Average age = 2.9 yr; age range = 1 to 7 yr.

**TABLE 6 Summary of Noncoordinated Fleet in the Study Area**

| Year of Model | Type | Number |
|---|---|---|
| 1968 | Bus | 1 |
| 1973 | Minibus | 2 |
| 1974 | Minibus | 2 |
| 1975 | Bus, minibus, van | 12 |
| 1978 | Minibus, van | 7 |
| 1979 | Bus, minibus, van | 8 |
| 1980 | Bus, minibus, van | 13 |
| 1981 | Bus, minibus, van | 10 |
| 1982 | Bus, minibus, van | 6 |
| 1983 | Minibus, van | 20 |
| 1984 | Van | 1 |

Note: Average age = 5.4 yr; age range = 2 to 17 yr.

fewer vehicles and a positive vehicle replacement program, whereas the noncoordinated programs have no policy for replacing aged or inoperable vehicles. The age of noncoordinated program vehicles ranges from 2 to 17 years. In addition, most of these vehicles are serviced by local garage facilities because they have no access to county garages. Therefore, all of these vehicles have varying maintenance standards. No vehicle inspection is performed by a state oversight agency, so the safety and serviceability of noncoordinated vehicles is an agency responsibility.

The condition of vehicles is important to the reliability of service. In rural areas, a vehicle breakdown results in delays with groups of people stranded in remote areas. The condition of vehicles is directly linked to service reliability, service attractiveness, and passenger confidence.

## Performance Indicators

An evaluation of the data reported for both types of transportation providers was done and performance indicators were developed and compared. Select performance indicators were used to compare the efficiency and effectiveness of the two types of systems. By necessity, these were limited because the lack of data for noncoordinated programs restricted what could be done. The indicators selected included the following:

- Number of miles per vehicle (indication of effectiveness),
- Cost per mile (indication of efficiency),
- Cost per vehicle (indication of efficiency),
- Cost per trip (indication of efficiency), and
- Number of passengers per mile (indication of effectiveness).

Number of miles per vehicle for coordinated programs registered a high level of performance. Performance (in number of miles per vehicle) of programs in the coordinated counties combined exceeded performance of the noncoordinated counties' programs by 95,205 miles, or 177 percent. Because the data for the noncoordinated systems were not audited and only reported once a year, it remains unclear whether cost figures of social service agencies were reliable.

The noncoordinated programs did not report number of passenger trips; therefore the number of passengers per mile, number of passengers per vehicle, and cost per trip calculations could not be made. The information given in Table 7 was reported for both coordinated and noncoordinated programs.

**TABLE 7 Comparison of Average Performance Measurements**

| Indicator | Coordinated | Noncoordinated |
|---|---|---|
| No. of miles per vehicle | 26,465 | 11,909 |
| Cost per mile ($) | 0.59 | 0.51 |
| Cost per vehicle ($) | 15,493 | 6,027 |
| Cost per trip ($) | 1.76 | NA |
| No. of passengers per mile | 0.35 | NA |

Note: NA = not available.

## GDOT Service Policy for Coordinated Operations

To provide direction and guidance for improved service delivery and operating cost-effectiveness, GDOT has implemented a service policy for all rural public transportation (coordinated) operators. Each of the rural public transportation programs funded under the UMTA Section 18 Program is evaluated annually in a certification process to assess system performance relative to service policy guides. The annual certification of coordinated programs results in an overall rating of certified, conditionally certified, or not certified. The annual certification is conducted by the GDOT staff, and certification is a condition for approval of annual funding applications. Four major certification categories are reviewed to determine conformance with applicable federal and state program requirements. The categories reviewed include

- Recipient's understanding of Section 18 Program requirements,
- Marketing,
- Technical assistance, and
- Administrative and operational responsibilities.

This review process allows each of the public transportation operators to assess performance and identify improvements for continued system operations. The service policy was created with coordination as a major goal and includes operation performance criteria to evaluate coordination. Four examples of these criteria are as follows.

1. Service should be complementary and not duplicate any other service.
2. Monthly ridership should be 500 passenger trips per vehicle.
3. Level of vehicle utilization should be 120 hours per month.
4. Number of monthly vehicle miles should be 1,000 miles per active vehicle.

Based on these four service policy criteria, analysis of the two types of programs (coordinated versus noncoordinated) indicates the following:

• Service for the coordinated programs was not duplicated whereas the noncoordinated service may have been duplicative.

• All of the coordinated transportation systems met the criterion target of 500 passenger trips per month per active vehicle. However, because number of passenger trips was not available for the noncoordinated systems, a comparison of both types of systems could not be made.

• All of the coordinated programs met the standard of 1,000 miles per month per active vehicle. Only one of the noncoordinated counties satisfied this criterion.

## Coordinated Social Service Programs

In 1984, the Georgia Department of Human Resources initiated two demonstration transportation programs in the state that provide coordinated social service transportation operations. One of the demonstration programs was a single-county operation whereas the other demonstration program consisted of a five-county regional service. These two demonstrations combined transportation services for aging, child development, community service block grant, mental retardation, mental health, Head Start, UMTA Section 16(b)(2), and other community programs.

Because the intention of this paper is to compare the differences between coordinated public transportation programs and noncoordinated social service transportation systems, only a limited comparison was made with the coordinated social service transportation providers.

A review of the operations information indicated that the social service coordinated systems met some of the service criteria (see Table 8). This would indicate that social service transportation can achieve a more efficient program operation through coordination.

**TABLE 8 Comparison of Service Policy Criteria with Coordinated Social Service Programs**

| Monthly Service Criteria | GDOT Monthly Service Policy Standard | Single County | Five-County Area |
|---|---|---|---|
| No. of trips | 500 | 720 | 219 |
| No. of miles | 1,000 | 1,342 | 1,167 |
| Passengers/mile | 0.50 | 0.53 | 0.19 |

## CONCLUSION

A review of available data from select rural counties in Georgia indicates that coordinated transportation systems provide more efficient and effective service than those that are not coordinated. Coordinated systems have better equipment inventory and have access to county maintenance facilities and supplies, which contribute greatly to better operations. Unlike noncoordinated systems operated by social service agencies, transportation is the primary service provided by the public transportation (coordinated) programs. In noncoordinated operations, transportation is an ancillary function only necessary for the delivery of agency programs. Therefore the noncoordinated transportation service is limited and exclusionary.

In cases in which social service transportation program operations are coordinated, operations performance approaches the efficiency and effectiveness of public transportation programs. Otherwise, noncoordinated systems do not compare well with the operations of coordinated systems.

A major factor in the success of the coordinated systems in Georgia is the involvement of the local government. As county operations, these systems have increased stability through county financial and operational support. In addition, the coordinated systems benefit greatly from the state DOT policy on service standard requirements and regular vehicle inspections. This policy encourages the continued improvement of service delivery for rural public transportation programs.

Some caution must be exercised with the conclusion. Data for the noncoordinated systems are weak, and therefore only broad comparisons are possible. However, the clear indication is that coordinated systems work better, provide better service, and have a broader base of support than do noncoordinated programs. For state and local governments interested in increasing program effectiveness, coordination is a viable solution.

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# Absenteeism, Accidents, and Attrition: Part-Time Versus Full-Time Bus Drivers

CHARLES A. LAVE

ABSTRACT

When the use of part-time drivers was first proposed, there was some question as to whether they would be as reliable and committed as were full-time drivers. This paper provides comparative data to answer that question. ABSENTEEISM: the data indicate that part-time work has inherently lower absenteeism; holding sick-pay and probation effects constant, part-time drivers have less absenteeism than full-time drivers. This result becomes apparent when following an identical cohort over time as it moves between full-time and part-time work, and also in cross-section data across groups. The data also indicate that increases in the number of sick days allowed cause an increase in absenteeism for both part-time and full-time drivers. ACCIDENTS: holding constant hours of driving exposure, years of experience, and the daily time pattern of accidents, part-time drivers have lower accident rates. However, only one transit agency had sufficient data to permit this standardization. There is also an important daily pattern to accident rates: they do not increase and decrease as a function of the daily traffic cycle, but rather as a function of the daily human cycle--increasing in mid-afternoon to reach approximately the same rate on both weekdays and weekends. ATTRITION: there is a tendency for transit agencies to hire the wrong people for part-time work; 75 to 85 percent of those hired actually wanted full-time work, which leads to greater turnover and increased training costs. The quit rates of part-time drivers vary strongly with external economic conditions, moving inversely with the local unemployment rate.

When the use of part-time (PT) vehicle operators was first proposed, one of the principal concerns was whether part-time operators (PTOs) would be as committed and reliable as were full-time operators (FTOs). A number of these concerns are examined and it is concluded that, in general, PTOs are dedicated, competent employees whose performance is usually as good as, or better than, that of FTOs.

These conclusions are based on detailed case studies at five transit agencies. The agencies are a diverse group having a wide variety of experience with PT labor. They range in size from 60 to 1,100 buses, in peak/base ratio from 1.2 to 3.5, and in operating environment from new western suburb to long-established northeastern city. Interviews were conducted from 1982 to 1984, and each agency was visited at least twice. Detailed data were collected on scheduling and operator performance, and interviews were held with operations managers, department heads, union leaders, and vehicle operators. (Detailed descriptions of the agencies and methodology are contained in Chomitz and Lave (2) and Chomitz, Giuliano, and Lave (3).

## COMPARATIVE ABSENTEEISM: PTOs VERSUS FTOs

The analysis concentrates on absenteeism resulting from sickness, although there are some data on injuries as well.

Table 1 presents comparative sick rates, PTO versus FTO, for all five of the case study agencies. The rates are computed as percentage of work days per year when an operator calls in sick. The FTO sick rate exceeds the PTO rate at every agency and, on average, it is 2.3 times higher.

**TABLE 1 Comparative Sick Rates: PTOs Versus FTOs (%)**

| | Seattle Metro | OCTD[b] | SEMTA[c] | Tri-Met[d] | CCCTA[e] |
|---|---|---|---|---|---|
| FTO sick rate[a] | 3.75 | 3.52 | 2.31 | 4.29 | 4.02 |
| PTO sick rate | 1.41 | 1.71 | 1.02 | 1.59 | 1.60 |

Note: Yearly cross-section data, with nothing held constant, that is, varying amounts of fringe benefits and sick pay.

[a]Proportion of yearly work days an operator will call in sick.
[b]OCTD = Orange County Transit District.
[c]SEMTA = Southeastern Michigan Transportation Authority. SEMTA is an unreliably small sample.
[d]Tri-Met = Tri-County Metropolitan District of Oregon.
[e]CCCTA = Central Contra Costa Transit Authority.

The five agencies represent a considerable range of sick leave policies: the number of paid sick days per year varies from 0 to 12; the degree of enforcement on required doctor's certificates varies considerably; one agency begins paying sick pay on the first day of illness, other agencies do not begin payments until the third day; and policies on accrual of unused sick leave vary considerably as well. These interagency variations can be used to explore the reasons why PTOs have lower sick rates.

### Differences in Sick Pay as an Explanatory Factor

The customary explanation for the lower sick rate of PTOs is that PTOs do not receive sick pay, therefore, they cannot afford to be sick. Two of the agencies, Orange County Transit District (OCTD) and Central

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Costa County Transit Authority (CCCTA), provide examples in which PTOs and FTOs receive identical sick benefits. If the customary explanation is correct, and sick pay differences are the important causal factor, then it would be expected that PTO and FTO sick rates would be nearly identical.

At CCCTA, FTOs receive no paid sick leave during their first year, and PTOS never receive sick pay. These groups allow a natural comparison because both are relatively new to the job, and both should have similar concerns about acquiring good work records. (The PTOs are on informal probation because most of them want to be chosen for full-time work eventually. The FTOs are in their first year of work and hence are on formal probation for almost all of the period covered by these data.)

Table 2 gives comparative sick and injury rates for FTOs and PTOs. The rates are expressed as percentage of work days when the operators call in sick. Four different rates are reported. Rate SI is based on total sick and injured days; rate S is based on sick days only. In small samples like this, the presence of a few random instances of major illness can substantially bias the apparent rate. Thus, rate S40 excludes any operator who was sick more than 40 days (8 weeks); and rate S30 excludes any operator who was sick for more than 6 weeks. (Neither S40 nor S30 screening ever excludes more than 10 percent of the sample.) Proof that the S40 and S30 rates do standardize against random events can be observed by comparing the SI rates for PTOs against the S40 rates: the SI rates vary by almost two to one, whereas the S40 rates are close to each other.

**TABLE 2 Comparison of FTOs with no Sick Pay and PTOs with no Sick Pay**

| | SI (%) | S (%) | S40 (%) | S30 (%) | No. of Operators |
|---|---|---|---|---|---|
| FTOs with no sick pay | | | | | |
| Hired in 1982 (1983 data) | 5.87 | 3.92 | 3.56 | 3.03 | 18 |
| Hired in 1983 (1984 data) | 5.61 | 3.27 | 3.27 | 2.39 | 18 |
| PTOs with no sick pay | | | | | |
| Hired in 1982 (1983 data) | 1.67 | 1.67 | 1.67 | 1.67 | 18 |
| Hired in 1983 (1983 data) | 2.93 | 2.93 | 1.64 | 1.64 | 41 |
| Hired in 1983 (1984 data) | 2.36 | 2.36 | 1.52 | 1.52 | 23 |
| Hired in 1984 (1984 data) | 2.93 | 2.93 | 1.58 | 1.58 | 33 |

Note: SI = total number of sick and injured days. S = sick days only. S40 excludes operators who were sick more than 40 days. S30 excludes operators who were sick for more than 30 days. Data in these four columns are proportions of yearly work days.

Regardless of which definition is used, the CCCTA data indicate that PTO sick rates and injury rates are lower than FTO rates, even when both groups of operators have identical sick pay benefits. Something other than sick pay is making an important difference between PTO and FTO sick rates.

OCTD provides another instance in which PTOs and FTOs have identical sick benefits. It has a class of PTOs who receive 12 days per year of allowable sick pay, which is identical to the sick benefits of their FTOs. Comparative sick rates (using the S30 rate definition discussed) are FTOs = 3.25 percent and PTOs = 2.44 percent. Again, despite the existence of identical sick benefits, the PTO absenteeism rate is lower.

Table 2 and the percentages given in the preceding paragraph both involve cross-section data: two samples of operators are examined at a single point in time under the implicit assumption that the only difference between the two samples is their PT versus FT status. Obviously, such an assumption may not be correct in general, but OCTD provides a chance to validate it. OCTD allows one particular group of operators to switch back and forth between FT and PT status, while maintaining full sick leave benefits. (Some FTOs choose to switch to PT status during the summer, or to have a period of lighter duties, etc.) By examining the absentee records of these operators, both sick benefits and any possible variation in personal characteristics--for example, age and motivation--that might be related to absenteeism are held constant. The results show that there is a decline in absenteeism for FTOs when they move from FT runs to PT runs: the reported sick rates (excluding operators who were sick longer than 40 days) were FT runs = 4.50 percent and PT runs = 2.44 percent. Again, it can be observed that a lower sick rate is associated with PT work than with FT work. This does not mean that absenteeism is independent of sick pay (in the section Increases in Sick Pay Cause Increases in Absenteeism, it is demonstrated that there is a strong effect). Rather, the effects of sick pay are not sufficient to explain the difference in absenteeism between PTOs and FTOs.

## Effect of Probation on Sick Rate

Probation is another factor that has often been cited as an explanation for the low PTO sick rate. Probation tends to keep operators on their best behavior, and PTOs spend a much higher proportion of their career with that status. The PTO probation period is often the same number of hours as the FTO probation period, but given their lower number of hours per day, PTOs spend more calendar days on probation, for example, for a typical 1,040-hr probation period, an FTO would be off probation in 6 months, but a PTO averaging 4 hours per day would be on probation for an entire year.

To measure the effects of probation, cohorts of PTOs and FTOs who had both begun work about the same time (roughly 1980) were identified, and their absentee records for a period about 3 years later were examined. The PTOs would be long past the probation period at this point, and both cohorts would have similar clock time on the job. Each cohort contained approximately 300 operators.

For each cohort, absentee records from June 1982 to June 1983 were examined. In each case, days sick plus days on workmen's compensation were added together. The absence rate for the PTOs was 0.067, and the rate for FTOs was 0.160; thus the FTOs were absent about 2.4 times more often than the PTOs. That is, for matched groups of operators, all well past their probation periods, the FTOs were absent more than twice as often as the PTOs.

Also compared were the absenteeism of this PTO cohort and the absenteeism of the total PTO population, most of whom have been hired more recently and hence are still on probation. The absentee rate for the total PTO group was 0.043, compared with the 0.067 rate for the older PTO cohort. That is, the older cohort is about 50 percent more likely to be absent. Thus it is concluded that probationary status does reduce absenteeism, but it is nowhere near a large enough factor to explain the general difference in absentee rates between PTOs and FTOs.

## Regularity of PTO Baseline Sick Rate

One interesting sidelight on the PTO sick rates is their apparent consistency among transit agencies. There are data on absenteeism from four agencies (the sample from SEMTA is only 20 observations, which is too small to use for comparative purposes), and all have PTO sick rates of about 4 days per year.

Observed number of days sick per year for PTOs (yearly cross-section data from agencies with large samples) is as follows: Seattle METRO, 3.6 days; OCTD, 4.4 days; Tri-Met, 4.1 days; and CCCTA, 4.1 days. At CCCTA, this rate holds up for 2 separate years of data; the data for Metro, OCTD, and Tri-Met are for a single year's sample. The four agencies have in common their lack of paid sick leave for PTOs, but they differ on everything else--degree of supervision, attention placed on absenteeism, and so on. Pending additional work, it is probably best to regard the commonly observed 4-day sick rate as an interesting coincidence.

### Some Speculative Guidance for Future Research

It has been observed that there is something inherent in PT work assignments that produces lower sick rates. Why might this be true? Three possible explanations are offered as a possible starting point for future research.

- Hypothesis 1: PTOs cannot afford to be absent. PT assignments produce barely enough money to live on, hence PTOs have a high incentive to show up for work. (Even in those agencies in which PTOs do get sick pay, they do not receive it on the first day of absence.) If this hypothesis were true, one would expect to find two effects: (a) that the difference in sick rates between PTOs and FTOs will disappear at agencies where PTOs get sick pay on the first day; and (b) that the difference in sick rates will be larger at agencies with no sick pay.
- Hypothesis 2: It is easier to work a short assignment than a long one if you are feeling sick. Hence, for any given degree of illness, an operator is more likely to report for work if he is facing an easy assignment. If this hypothesis were true, one might expect to find that the PTO sick rate moves closer to the FTO rate at transit agencies where PTOs work two shifts a day.
- Hypothesis 3: PTO status is similar to being on probation all the time; PTOs try particularly hard to acquire good work records because most PTOs want to be promoted to FT work. Although this appears to be a reasonable idea, the evidence at OCTD does not support it: regular operators may switch back and forth between FTO and PTO status, and hence are under no probation pressure, but they have lower absenteeism when they work part time.

## PTOs VERSUS FTOs: OTHER ISSUES

### Missout Rates

Although illness and injury are the major categories of absenteeism, there are other components as well. Missouts refer to situations in which an operator misses a run because of showing up late, oversleeping, and so forth. Because the definition of missouts appears to vary among agencies, it is not valid to compare rates across agencies. However, PTO versus FTO comparisons within a single agency should be valid. Table 3 gives a summary of the data across the five case study agencies. The results are decidedly mixed: PTO missout rates are lower than FTO rates at OCTD and Tri-Met (for three of the four categories), but they are higher at the three other agencies. In any event, the differences are small compared with the difference in sick rates between PTOs and FTOs. Thus, overall, if a reliability index, were to be formed by combining the sick rate and the missout rate, it is still apparent that the PTOs are more reliable than the FTOs.

**TABLE 3 Comparative Missout Rates: PTO Versus FTO (%)**

| | Seattle Metro | OCTD | SEMTA | Tri-Met | CCCTA |
|---|---|---|---|---|---|
| PTOs | 0.55 | 1.0 | 1.20 | 0.66 | 0.67 |
| FTOs | 0.35 | 1.5 | 0.60 | 0.44 | 0.38 |
| FT extra board | – | – | – | 0.86 | – |
| FT regular relief | – | – | – | 0.81 | – |
| FT vacation relief | – | – | – | 1.07 | – |

Note: Transit agencies are defined in Table 1. All figures are expressed as percentages of days per year. For Seattle Metro, data on late and unexcused absences were combined. The sample at SEMTA is too small—only 20 operators.

### Allowing Operators To Switch from FTO to PTO Status

OCTD has initiated a unique innovation in the use of PT labor that increases the work options available to FT operators. Their FTOs bargained for the right to bid PT work runs during a given sign-up period. Those FTOs who go part-time retain their seniority and their full benefits: sick pay, holidays, vacations, leave and so forth. (Operators retain full health insurance, but pay for the other benefits is proportional to hours worked; for example, a regular operator on temporary PTO status, with a 3-hr run, would receive 3 hr of sick pay if he became sick.) However, for the duration of that sign-up period, they work fewer hours and receive less total salary. At the end of the sign-up period, they can return to FT status or remain on PTO status for another sign-up period. The FTOs wanted this as an option for situations such as a female FTO who wanted to spend more time with her children during the summer, an FTO suffering from burnout who wanted a period of reduced stress, and a chronically ill operator who needed a period of reduced work to regain his health.

Thus, the agency now has three classes of operators: FTOs; type A PTOs, who receive full fringe benefits; and type B PTOs, who receive no sick benefits. FTOs may switch into and out of the type A PTO status. During the first year, 16 regular FTOs decided to try a stint as PTOs. Subsequently 10 returned to FT status, and 6 elected to remain on PT status. Because they served in both PT and FT status during the year. Table 4 gives their records separately for the two types of work. The first two rows include all 16 operators, but 5 had unusually high sick or injury records (more than 40 days per year); the next two rows give the absentee records of the 11 operators with more typical sick rates. In the other agencies, the proportion of drivers exceeding the 40-day criterion is usually less than 10 percent. Why should there be 5 out of 16 here? These 5 operators all had unusually high sick or injured rates before bidding for PTO status. It is not known whether they chose PTO status to ease their work burden, or whether they were informally pressured into it by management, although the fact that 2 of the 5 have returned to FT status suggests that the decision was their own choice.

**TABLE 4 Record of Type A PTOs (%)**

| | Sickness | Missout | Injury |
|---|---|---|---|
| All data included | | | |
| While serving as FTO | 8.90 | 1.85 | 4.58 |
| While serving as PTO | 9.92 | 1.76 | 0.64 |
| Without high sick or injury records | | | |
| While serving as FTO | 4.50 | 1.69 | 0.00 |
| While serving as PTO | 2.44 | 2.07 | 0.98 |

Given the small size of the sample, and hence the way in which a single random instance of major illness or injury can affect the group average, it is probably best to concentrate on the last two rows, the rates that screen out the unusual incidents. The decrease in sick rate from 4.50 to 2.44 percent following a move to PT status is interesting. Sick benefits are identical in the two statuses, so there is no economic reason that might explain the change. [Perhaps after the typical 8-hr (or more) day of the FTO, the 3 (or more) hr of a typical PT shift appears to be so easy that a marginally sick operator will report for work anyway.] Missout rates do not change much, and they are similar to the FTO rates at this transit agency. There is an insignificant increase in the injury rate when operators move from FT to PT status.

It is also interesting to compare the records of those operators who chose to bid for PT status with those who did not. Table 5 gives a summary of the relevant data, and it is clear that the drivers who decided to try PT status had previously had higher sick and injury rates than did their colleagues. This is true whether comparing the total data in Rows 1 and 2, or the screened data in Row 3. After the move to PT status, their absenteeism decreased by almost one-half, from 4.50 percent (Row 3) to 2.44 percent (Row 4). That is, looking at the decision to bid PT status, the group that decided to move to PT status had previously been characterized by above-average absentee rates, but following the move to PT status their rates improved to become better than the average.

**TABLE 5 Operators Who Bid PT Versus Those Who Did Not (%)**

| | Operators Who Bid for PT Work | Operators Who Did Not |
|---|---|---|
| All data included | | |
| Sick rate on FT status | 8.90 | 6.09 |
| Injury rate on FT status | 4.58 | 3.58 |
| Without high sick or injury records | | |
| Sick rate on FT status | 4.50 | 3.52 |
| Sick rate on PT status | 2.44 | NA |

This agency provides an example of implementing PT labor to benefit the operators. There are no direct cost savings for the transit agency; it may even be slightly more expensive. (The agency agreed to the new policy as a bargaining concession to labor, in return for the agency winning the right to create an unusually inexpensive class of PTOs--one with lower wages and few fringe benefits.) From the viewpoint of the existing FTOs, the new policy is a major benefit that provides them with significantly more choices in their work lives.

### The Effect of Irregular Work on Absenteeism

Tri-Met had enough detailed data to allow calculation of absenteeism broken down by the type of work assignment: part-time, regular full-time run, and extra board. The data in Table 6 indicate the effect of work type on absenteeism. There is some tendency for absenteeism to increase on irregular work assignments--those where an operator is not experienced on the particular route. The extra-board operators have more absenteeism in most of the categories. It appears likely that this results from their irregular work shifts--the degree to which the operators have to deal with continually differing routes and times. (When the accident data are analyzed a similar relationship subsequently is found between work irregularity and accident rate. It is possible that the increase in the number of accidents with work irregularity occurs because the operator is unfamiliar with the route and is not able to devote full attention to basic driving. It is also possible that the increase in absenteeism with work irregularity occurs because of the higher stress of the unfamiliar runs.)

**TABLE 6 Effect of Work Type on Absenteeism (days/yr)**

| Absentee Category | Extra Board | Regular Run | PT Run |
|---|---|---|---|
| Absent | | | |
| Excused | 2.25 | 1.26 | 1.51 |
| Unexcused | 0.61 | 0.17 | 0.07 |
| Sickness | 9.10 | 11.15 | 4.13 |
| Workmen's compensation | 8.88 | 6.32 | 6.10 |
| Sick persons performing light-duty work | 0.19 | 0.21 | 0.00 |
| Persons on workmen's compensation performing light-duty work | 3.43 | 1.98 | 1.15 |
| Oversleep | 2.15 | 1.10 | 1.77 |
| No. of driver-weeks of data | 9,244 | 30,958 | 5,554 |

## INCREASES IN SICK PAY CAUSE INCREASES IN ABSENTEEISM

In the section on Comparative Absenteeism, it was found that differences in sick benefits by themselves were not sufficient to explain the differences in absenteeism between PTOs and FTOs. That does not mean that the sick benefit differences are unimportant. In this section, an attempt is made to measure the effects of paid sick leave on the observed sick rate.

At CCCTA, operators have no paid sick leave their first year, and receive higher amounts of paid leave as their careers advance. This makes it possible to examine the experience of a fixed cohort of operators as they acquire progressively higher benefit levels, that is, the operators remain the same while the sick benefits vary. In Table 7 the sick rate behavior of two separate groups of operators is followed over time. Cohort No. 1 is a group in which drivers begin with no paid sick leave their first year, and move to 3 days of paid sick leave their second year; the result is an increase in the observed sick rate.

**TABLE 7 Sick Rate Behavior of Two Groups of Operators Over Time**

| | 1983 Sick Rate | 1984 Sick Rate |
|---|---|---|
| Cohort No. 1 | | |
| Observed no. of sick days | 8.5 | 9.1 |
| Allowable no. of paid sick days (days/yr) | 0 | 3.0 |
| Cohort No. 2 | | |
| Observed no. of sick days | 10.5 | 13.5 |
| Allowable no. of paid sick days (days/yr) | 5.2 | 12.0 |

Cohort No. 2 is a more experienced group of drivers, hired under an earlier, more generous contract. In 1983 they were entitled to an average of 5.2 paid days of sick leave each, and in 1984 they were entitled to 12 paid days per year; the result was an increase in the observed sick rate. As driver cohorts obtain more allowable paid sick leave, their observed sick rate increases.

OCTD data offer cross-section evidence on the relation between absenteeism and sick pay. It has one class of PTOs who receive no sick pay and another class of PTOs who receive 12 days of allowable sick pay per year. The following table gives a comparison of observed sick rates for the two groups of PTOs.

| | PTOs with 12 Days of Paid Sick Leave (%) | PTOs with 0 Days of Paid Sick Leave (%) |
|---|---|---|
| Major sick rate: total sick and comp incidents | 9.92 | 4.26 |
| Baseline sick rate: (excluding employees with >40 sick days) | 2.44 | 1.48 |

It can be observed that the group with more sick benefits has a much higher sick rate; that is, PTOs who receive paid sick leave have higher rates of absenteeism than do PTOs who do not receive sick pay. This result is true whether the comparison is made using the A rate (all sickness and injury), or the C rate (only sickness; excluding drivers with random, major episodes of sickness).

Cross-section data at CCCTA allow a somewhat more precise measurement of the effect of increasing sick benefits. CCCTA began with a provision for 12 paid sick days per year, but several years later began hiring new operators under a provision that gave them only 3 paid days per year, which increases to 6 paid days as they acquire more seniority. Sick pay is earned the first calendar year of service, on a pro rata basis, and is then available for use during the second calendar year. Thus, because the existing operators were hired under two different sets of benefit rules, and because operators earn differing amounts of sick benefits for use during their second calendar year of service, this agency provides observations for FTOs with four different levels of paid sick leave: 0, 3, 5.2, and 12 days.

The data in the first row of Table 8 indicate the amount of paid sick leave allowed and the data in the second row indicate the observed sick rates, measured as the ratio of sick days to total work days (using the average of the C and D rates). The data in the third row express the sick rate in terms of days per year. It can be observed that increases in the observed sick rate go along with increases in allowable paid sick days.

The data in the fifth row indicate the difference in observed sick rates between adjacent columns. For example, when FTOs move from 5.2 allowable paid sick days per year to 12 allowable paid days per year, their observed sick rate increases by 3.2 days. The difference in allowable sick pay was 6.8 days (12 minus 5.2). Taking the ratio of observed increase to allowable increase, it can be observed that the sick rate increased by about one-half of the increase in sick benefits. This same rate of increase is observed between the other columns as well. Looking at it in overall terms, when operators receive no sick pay, they are sick 7.77 days per year; if they are allowed 12 paid days per year, the 12-day increase in benefits brings about a 5.93 day increase in sick days. That is, the observed sick rate of FTOs increases about one-half as fast as the increase in sick benefits.

## MEASUREMENT AND CONTROL OF ABSENTEEISM

### Measurement Patterns of Absenteeism

At Metro, detailed breakdowns of absenteeism data on a garage-by-garage (division) basis were available, which afforded the opportunity to search for patterns among garages. Usually, they would be expected to be alike over the course of the year because (a) all the garages are exposed to the same physical hazards (e.g., diseases and bad weather), and (b) all were exposed to the same temptations (e.g., holidays and hunting season); thus the change in the daily absentee rate should be more or less synchronized across the garages.

Figure 1 shows the sick rate at each garage over the course of the year. The vertical axis is percentage times 1,000, that is, 30 means 3 percent

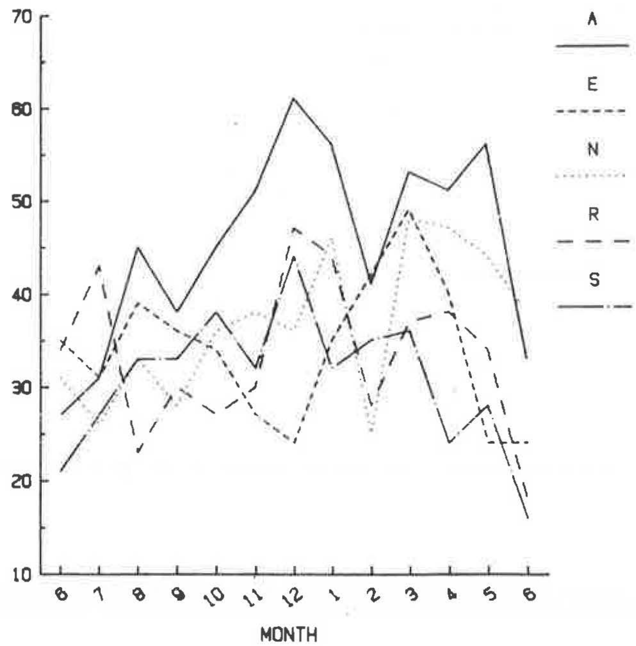


FIGURE 1 Sick rate at five garages over the course of a year.

TABLE 8 Amount of Allowable Sick Leave Compared with Amount of Absenteeism

| | No. of Paid Sick Days Allowed | | | |
|---|---|---|---|---|
| | 12 | 5.2 | 3 | 0 |
| Observed sick rate (yearly percentage) | 5.27 | 4.05 | 3.50 | 2.99 |
| Observed sick rate (days/yr) | 13.7 | 10.5 | 9.10 | 7.77 |
| Observed effect of paid sick leave: difference between adjacent columns (no. of days) | 3.2 | 1.4 | 1.3 | |
| Possible effect of paid sick leave (no. of days) | 6.8 | 2.2 | 3.0 | |
| Observed difference divided by possible difference (%) | 47 | 63 | 43 | |

daily sick rate. The five trend lines are vaguely similar, although not as close as was expected. Is the lack of similarity caused by differences in supervisory practices among the garages?

In Figure 2, the sick rate and the excused absence rate are added together, and the total over time is plotted. It is easy to observe that the five trend lines now look more similar. It appears that the actual pattern of absentee behavior is the same at the five garages, but the manner in which the dispatchers record the absences is different. At some garages, when a driver calls in, the dispatcher will be more likely to record it as an excused absence; at other garages the dispatcher is more likely to record it as a sick absence. Drivers are similar, but there is considerable variation in the permissiveness of supervisory personnel.

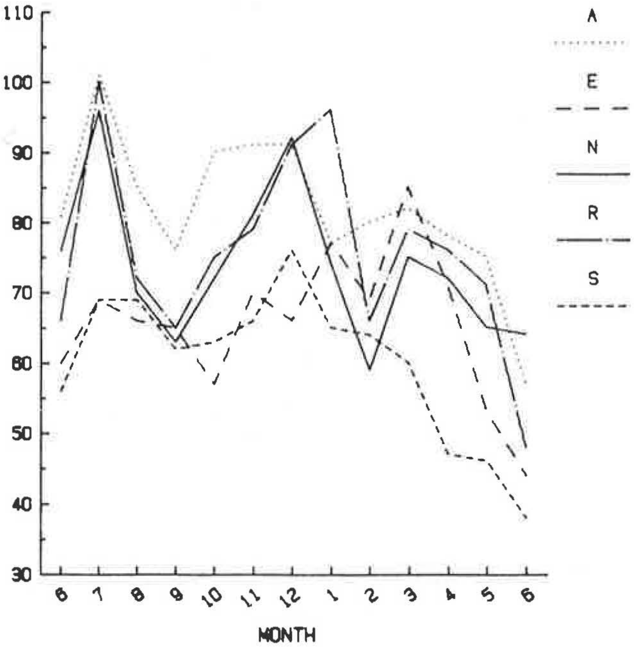


FIGURE 2 Total of sick rate plus excused absence rate plotted over time.

It is possible to use correlation coefficients to quantify these graphical patterns in a more formal way. If the drivers at the different garages did have similar absentee patterns, then the correlation coefficient between any two garages would be relatively high. Table 9 gives the correlations between the monthly pattern of sick rates at each pair of garages. The presence of all the coefficients in the .0-to-.2 range indicates that the similarity is not high.

Table 10 gives the correlations for the new variable, the sum of the daily sick rate and the daily excused absence rate. In Column 1, the intercorrelations between garages are given for this new variable, and in Column 2 the intercorrelations for the sick rate alone are given. The correlations in the left column are much larger than those in the right column. That is, the daily pattern of sick plus excused absence rates is more similar across garages than is the pattern of sick absence rates alone.

TABLE 9 Correlation of Sick Rates Across Garages

| | Garage A | Garage E | Garage N | Garage R | Garage S |
|---|---|---|---|---|---|
| Garage A | 1.00 | | | | |
| Garage E | -.04 | 1.00 | | | |
| Garage N | .67 | .06 | 1.00 | | |
| Garage R | .43 | .00 | .26 | 1.00 | |
| Garage S | .59 | .17 | -.04 | .33 | 1.00 |

TABLE 10 Correlation of Sick Plus Excused Absence Rates Across Garages

| | Sick Plus Excused | Sick Rate |
|---|---|---|
| Garage A with Garage E | .44 | -.04 |
| Garage A with Garage N | .74 | .67 |
| Garage A with Garage R | .74 | .43 |
| Garage A with Garage S | .79 | .59 |
| Garage E with Garage N | .31 | .06 |
| Garage E with Garage R | .61 | .00 |
| Garage E with Garage S | .53 | .17 |
| Garage N with Garage R | .78 | .26 |
| Garage N with Garage S | .55 | -.04 |
| Garage R with Garage S | .66 | .33 |

These results demonstrate why the analysis has been restricted to within-agency comparisons. That is, FTO versus PTO comparisons are made for each agency, rather than comparing the FTOs at one agency with the PTOs at another. If such large differences are observed between garages in a single agency, there is obviously significant measurement error in the sick rate data.

## Effect of No-Fault Absentee Policy at OCTD

Figures 1 and 2 also show a long-term decline in sick rates, resulting from changes in absentee policy as management became concerned about the financial effects of the high sick rate. High absentee rates have become a growing concern at most transit agencies. The response at two of the case study agencies involved the formulation of a new philosophy concerning absenteeism, as follows:

> All absences are the same because they are all equally costly to the agency. We are not concerned with issues of fault, or with the fact that a particular absence had a "good" cause. What matters is the end result, and operators who are unable to fulfill their duties consistently should find work in industries where reliability is not so critical.

The traditional discussion of absenteeism concentrated on why it happened and whether the operator was to blame. The new philosophy ignores such moral wrangling and concentrates on the occurrence itself. Thus, this approach has been called the no-fault philosophy: if an operator is injury prone or chronically sick, or has habitual problems with conflicting obligations, then that operator is not capable of meeting the reliability needs of the transit industry.

Three years ago, OCTD implemented a new absenteeism policy based on this philosophy:

> 14 Counted Absences per year are grounds for immediate dismissal. A Counted Absence is any kind of absence except for bereavement, jury duty, military duty or pre-approved leaves for personal business or union business. On long periods of illness, only the first two days are Counted Absences.
>
> If an operator has no miss-outs for 90 days, then all the old miss-outs are cleared

from the record; there is no limit to the number of times an operator may do such record-clearing. If an operator has no Counted Absences for 120 days, then all the old Counted Absences are cleared from the record, but this may only be done once each year.

Did the new policy reduce absenteeism? A number of detailed comparisons were made. First, examining the two months before the new policy and the two months after the new policy took effect, it was observed that absenteeism decreased from 11.9 to 10.1 percent, a 1.8 percent decrease. (Absenteeism is the sum of sickness, injury, personal holidays, and leave.) To be certain that this decrease was not only the effect of seasonal variation, an additional measure was computed. By using seasonally identical 25-week periods before and after the new policy (August 17 to February 7 for both years), an absenteeism rate of 11.2 percent was calculated for the period before the new policy and a 9.4 percent rate was calculated for the period afterwards, a 1.7 percentage point decrease. For these same two periods the numbers of leaves and missouts were also calculated and it was discovered that these were essentially unchanged; that is, the improvement in absenteeism was not offset by a corresponding increase in other categories.

Overall, the new policy is clearly a success and appears to have reduced absenteeism by 1.7 to 1.8 percentage points. To put this figure into perspective, it is noted that it is probably responsible for a larger cost saving than that resulting from the use of PT labor at this agency (1.2 to 1.6 percent).

## COMPARISON OF ACCIDENT RATES BETWEEN PTOs AND FTOs

Table 11 gives the comparative accident rates at CCCTA. PTO accident rates appear to be lower than those of FTOs on a per-year basis, although the data are not standardized for differences in driving exposure. The table also breaks down the accidents into chargeable and nonchargeable, where chargeable accidents are those that the operator could have prevented.

**TABLE 11 FTO Accident Rates Versus PTO Accident Rates**

| | FTO | FTO | FTO | FTO | PTO | PTO |
|---|---|---|---|---|---|---|
| Years of experience | 3.70 | 2.60 | 2.30 | 1.30 | 1.30 | 0.60 |
| Total accident rate | 1.33 | 1.50 | 1.17 | 1.59 | 1.17 | 0.95 |
| Chargeable accident rate | 0.49 | 0.27 | 0.34 | 0.59 | 0.58 | 0.38 |
| Nonchargeable accident rate | 0.84 | 1.23 | 0.83 | 1.00 | 0.59 | 0.57 |
| Sample size | 9 | 28 | 18 | 18 | 23 | 33 |

Note: Data are from CCCTA and are expressed in totals of all vehicle and passenger incidents.

Comparative accident rates at Tri-Met with data structured by the type of work assignment are as follows: extraboard, 2.20; regular run, 0.68; and PT run, 1.39. (Data are on a per-year basis, and driving exposure is not standardized.) The PTO accident rate is higher than that of FTOs who do regular runs, but lower or equal to that of regular drivers who do relief runs or extra-board work.

Accidents can also be broken down according to whether they are preventable or nonpreventable. The percentages of total accidents judged preventable are as follows: extra board, 45; regular drivers, 51; and PTOs, 60 (Tri-Met data). Thus, the PTOs are judged to have a higher proportion of preventable accidents. This might be an indication that PTOs are worse drivers, or it might be the result of misclassification: given the union opposition to PTOs, it is possible that the drivers who do the evaluation have some degree of bias against them.

The data in Table 11 and in the preceding two paragraphs give reports on accidents per year. However, this is not an entirely adequate statistic for judging the quality of the two driver groups. First, FTOs drive more and hence would be expected to have more accidents. Second, PTOs drive more during the congested hours of the day, which might increase their accident rates. Third, FTOs have much more experience, which ought to lower their accident rates. Fourth, there may be substantial differences in the driveability of the vehicles used by the two groups--size, age, and so forth. Ideally, the accident rates should be standardized for all of these different exposure factors. Attanucci, Wilson, and Vozzolo were able to standardize for exposure at the Massachusetts Bay Transportation Authority in Boston and found that PTOs had higher accident rates (1). However, the implementation of PT labor at MBTA was unusually difficult, probably a worst-case example in many respects, and even their accident situation has improved markedly since the initial period. Thus it is not clear that the Boston findings generalize to other transit agencies.

The data required to produce completely standardized accidents are extensive. For each accident one must have the following: (a) time of day, weekday versus weekend, PTO versus FTO; (b) driving experience of the operator; (c) daily platform time of that run; and (d) data on all the operators with the same experience and status who did not have accidents. The data on (a), (b), and (c) are stored in different files, maintained by different departments (Traffic Safety, Personnel, and Scheduling, respectively), and are often on different computers as well. Thus it was only possible to assemble a complete set of data files for Seattle Metro, and only for a 10-month period, January to October. The remainder of the section is based on these data.

The gross, unstandardized accident rates at Metro are PTOs, 0.529 accidents per operator; and FTOs, 0.930 accidents per operator. However, these data need to be adjusted for all the different exposure factors, beginning by looking at the effect of time-of-day on the accident rate. Table 12 gives numbers of accidents per bus hour of service, as a function of time. The table is in three main parts: accidents on weekdays, Saturdays, and Sundays. For each of the three parts the number of accidents, the number of buses in service at that hour, and accidents per bus hour are given. (The number of weekday buses is multiplied by 5 before dividing; accident rates are for the whole 5-day week, so number of buses needs to be expanded to match it. The final rates are multiplied by 100 for ease of presentation.)

A number of things should be noted in Table 12. Looking at Column 3, the PTO accidents occur during the daily peak hours because that is the period during which these operators are utilized. Note that accidents per bus hour vary considerably by time of day, ranging from a low of 0.38 accidents per bus at 5 a.m. to a high of 4.52 accidents per bus at 4 p.m.

Finally, and surprisingly, the weekend rates are not very different from the weekday rates, despite the substantially lower level of weekend traffic. Not only are the accident levels similar between weekday and weekend, but even the hourly patterns appear to be similar. One possible explanation of these data is that accidents vary as a function of the daily human cycle, not the daily traffic cycle.

TABLE 12 Daily Pattern of Accidents

| | Weekdays | | | | | Saturday | | | Sunday | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour | No. of FTO Accidents | No. of PTO Accidents | Total No. of Accidents | No. of Buses | No. of Accidents/ Bus | No. of FTO Accidents | No. of Buses | No. of Accidents/ Bus | No. of FTO Accidents | No. of Buses | No. of Accidents/ Bus |
| 4 a.m. | 0 | 2 | 2 | 70 | 0.57 | 0 | 10 | 0.00 | 0 | 9 | 0.00 |
| 5 a.m. | 3 | 4 | 7 | 373 | 0.38 | 2 | 84 | 2.38 | 0 | 54 | 0.00 |
| 6 a.m. | 14 | 23 | 37 | 818 | 0.90 | 0 | 173 | 0.00 | 2 | 119 | 1.68 |
| 7 a.m. | 51 | 61 | 112 | 846 | 2.65 | 2 | 202 | 0.99 | 0 | 137 | 0.00 |
| 8 a.m. | 62 | 67 | 129 | 769 | 3.36 | 4 | 218 | 1.83 | 0 | 149 | 0.00 |
| 9 a.m. | 45 | 9 | 54 | 460 | 2.35 | 7 | 227 | 3.08 | 3 | 159 | 1.89 |
| 10 a.m. | 49 | 0 | 49 | 300 | 3.27 | 3 | 231 | 1.30 | 2 | 167 | 1.20 |
| 11 a.m. | 46 | 0 | 46 | 303 | 3.04 | 10 | 232 | 4.31 | 3 | 175 | 1.71 |
| noon | 67 | 0 | 67 | 306 | 4.38 | 8 | 233 | 3.43 | 3 | 183 | 1.64 |
| 1 p.m. | 72 | 0 | 72 | 383 | 3.76 | 11 | 236 | 4.66 | 5 | 180 | 2.78 |
| 2 p.m. | 87 | 15 | 102 | 452 | 4.51 | 6 | 234 | 2.56 | 7 | 175 | 4.00 |
| 3 p.m. | 87 | 71 | 158 | 702 | 4.50 | 11 | 233 | 4.72 | 4 | 176 | 2.27 |
| 4 p.m. | 92 | 98 | 190 | 841 | 4.52 | 15 | 233 | 6.44 | 10 | 177 | 5.65 |
| 5 p.m. | 73 | 99 | 172 | 845 | 4.07 | 7 | 240 | 2.92 | 3 | 179 | 1.68 |
| 6 p.m. | 39 | 40 | 79 | 684 | 2.31 | 3 | 234 | 1.28 | 3 | 180 | 1.67 |
| 7 p.m. | 27 | 6 | 33 | 328 | 2.01 | 4 | 200 | 2.00 | 4 | 158 | 2.53 |
| 8 p.m. | 24 | 0 | 24 | 173 | 2.77 | 3 | 155 | 1.94 | 2 | 142 | 1.41 |
| 9 p.m. | 19 | 1 | 20 | 162 | 2.47 | 3 | 147 | 2.04 | 5 | 140 | 3.57 |
| 10 p.m. | 12 | 0 | 12 | 154 | 1.56 | 3 | 136 | 2.21 | 4 | 132 | 3.03 |
| 11 p.m. | 4 | 0 | 4 | 130 | 0.62 | 1 | 125 | 0.80 | 1 | 124 | 0.81 |
| Midnight | 4 | 0 | 4 | 112 | 0.71 | 1 | 107 | 0.93 | 0 | 108 | 0.00 |
| 1 a.m. | 5 | 0 | 5 | 85 | 1.18 | 2 | 82 | 2.44 | 3 | 108 | 2.78 |
| 2 a.m. | 2 | 0 | 2 | 42 | 0.95 | 0 | 44 | 0.00 | 0 | 82 | 0.00 |
| 3 a.m. | 1 | 0 | 1 | 7 | 2.86 | 0 | 7 | 0.00 | 0 | 43 | 0.00 |

Note: No. of Accidents/Bus = accidents per bus in service (x 100). For weekday runs, number of buses is multiplied by 5 before computing No. of Accidents/Bus. Data are from Seattle Metro.

Obviously, more work is needed before such a generalization can be made with confidence, but it is a fascinating notion. In any event, whether the daily pattern of accidents is due to congestion patterns or to some inherent human cycle, the important consideration for the analysis is that PTOs drive during those periods when accident rates are at their highest.

The greater exposure of PTOs to high-accident driving times must be standardized first. The great share of PTOs drive during two time periods, 6 to 8 a.m. and 3 to 6 p.m. During these periods there are 877 total accidents, and there are 5,505 buses in daily operation. The accidents occur over the entire 5-day week, so buses are multipled by 5 and the following is computed: accidents peak bus hour = 3.19 (multiplying the ratio by 100 for ease of presentation). There are 504 accidents during the nonpeak weekday hours, and there are 3,840 buses in service, thus 504/(5 x 3,840) is computed; for Saturday there are 106 accidents and 4,023 bus hours of service; and for Sunday there are 64 accidents and 3,047 bus hours of service. Thus the average accident rate for the nonpeak hours is 2.57 accidents per bus hour of service. Only FTOs drive during these low-danger, nonpeak hours; the PTOs all drive during the high danger peak hours.

Taking the ratio of these two figures, it would be expected that, other things being equal, the more dangerous driving hours of the PTOs would lead to a 24 percent higher accident rate. Next, the effects of driving experience and hours of exposure are analyzed.

The number of accidents per operator (over the 10-month period) is computed separately for the different experience cohorts of PTOs and FTOs and the results are given in Table 13. Looking at the top of the table, notice that as experience increases, the accident rate of FT operators declines, from 1.52 accidents per operator for the operators with 1 year of experience down to 0.92 accidents per operator for those with 5 years of operating experience. However, the same trend is not apparent for the PTOs; their accident rate appears to be remarkably stable and independent of driving experience. However, this apparent stability is only an artifact of the differences in driving exposure.

TABLE 13 Effect of Experience on Accident Rate

| | FTOs | | PTOs | |
|---|---|---|---|---|
| Years of Experience | No. of Accidents[a] | No. of Accidents/ Driver | No. of Accidents[a] | No. of Accidents/ Driver |
| 1 | 114 | 1.52 | 77 | 0.46 |
| 2 | 49 | 1.02 | 91 | 0.42 |
| 3 | 12 | 2.40 | 95 | 0.45 |
| 4 | 58 | 0.84 | 101 | 0.51 |
| 5 | 197 | 0.92 | 51 | 0.77 |
| Weighted avg[b] | | 1.05 | | 0.48 |

Note: Data are for a 10-month period at Seattle Metro.

[a] Number of accidents used in computing the rate.
[b] Data are weighted by number of drivers in each category.

For the FTOs, the work week tends to be relatively independent of years of experience: for their first 5 years at Seattle Metro, all FTOs work approximately a 40-hr week (as they acquire considerably more seniority, they can bid for runs with more overtime or more guarantee pay). However, the situation for the PTOs is different. PTO runs range from 2.5 hr to almost 6 hr in length, and there is considerable competition to receive the long runs because these offer the highest pay. Data on the average driving time for each experience cohort of PTOs are not available, but there are data on the number and length of PTO runs. Because PTOs bid for runs at this agency, and because the operator interviews revealed that the longest trippers were the most desirable, a simple bidding simulation was performed: the longest runs were assigned to the PTOs with highest seniority and any leftover long runs were assigned to the next highest seniority group of PTOs; then the next longest group of runs was assigned to the remaining PTOs with highest seniority, and so on.

Table 14 gives the results of the run assignment

**TABLE 14 Adjustment for Differential Exposure by Part-Time Seniority**

| Years of Experience | Avg PTO Runs (min) | No. of Accidents/ PTO |
|---|---|---|
| 1 | 140 | 1.34 |
| 2 | 157 | 1.10 |
| 3 | 204 | 0.90 |
| 4 | 240 | 0.87 |
| 5 | 330 | 0.96 |
| Avg | | 1.03 |

Note: Data are for a 10-month period at transit Seattle Metro.

process. Column 2 gives the average PTO run varying between 140 and 330 min, depending on the amount of PTO seniority. To compute the final column: (a) first compute the ratio (FTO platform time divided by average PTO run time) for each PTO experience cohort, and (b) divide the raw PTO accident rates, from the top of the table, by the time ratio computed in (a). Note that the PTO accident rate now varies with driving experience, as expected. Also note that the PTO accident rates tend to be lower than, or about the same as, the FTO rates at each level of experience.

Overall, holding constant amount of driving experience and hours of exposure, the average FTO accident rate is 1.05 and the PTO rate is 1.03 (computed by using driver-weighted averages). These results do not standardize for differences in exposure to dangerous driving times, and that 24 percent adjustment would make the comparative PTO rate even lower. Thus, for Seattle Metro--after standardizing for hours of driving, exposure to dangerous driving, and years of driving experience--PTOs have lower accident rates than do FTOs. However, the relationship between accident rates and experience suggests that management should be concerned about the adverse consequences of operator turnover.

## ATTRITION RATES AND THE EFFECT OF HIRING THE WRONG PEOPLE

Attrition is of interest because it increases training costs and accident rates (high attrition rates mean that a higher proportion of operators are still on the high-accident portion of the experience curve). It had always been expected that PTOs would have higher attrition rates than FTOs--it was less likely that people would regard PT work as a permanent career. However, it is possible that the attrition rate is even higher than it needs to be because management may be recruiting the wrong people.

By wrong people, it is meant that most of the current PTOs had actually wanted FT work not PT work. Surveys were not conducted among the PTOs to calculate the proportion who actually wanted FT work, but both the unions and the managers were asked to make a subjective estimate of this proportion. There was universal agreement on an estimate that 70 to 85 percent of the PTOs wanted FT work. Such PTOs leave as soon as suitable FT work becomes available. If they could transfer to FT positions at the transit agency, there would be no loss of training and experience; however in an era of constant--or even declining--transit service, it is unlikely that many PTOs will be able to transfer.

The Operations staff at these agencies was well aware of the problem of hiring the wrong operators. However, in four of the five cases study agencies, no evidence was found that the Personnel Office had made any serious, determined effort to screen out those PTOs who were only taking PT work as a temporary expedient. At one of the four it appeared as if the Personnel Office had deliberately structured the hiring process toward people who would want FT work. The hiring office was located in the midst of a high-unemployment area (the type of place where true PT candidates--for example, housewives and students--were unlikely to go); it was only open for a few hours per week, and only at a time when employed candidates would be at work; it refused to accept job applications at its suburban divisions.

An indirect estimate of PTO attitudes toward FT work can be constructed by looking at the relation between PTO quit rates and the general economic conditions in the area. If PTOs really want FT work, then quit rates will be low during periods of high unemployment in the local area, and when the local job market becomes tighter PTO quit rates would be expected to increase significantly. However, the calculation cannot be done in a simple manner because the effects of operator longevity must also be standardized. Quit rates vary as a function of experience, and are likely to be highest in the early years when the driver is still trying to figure out if this is actually the type of job he wants. Thus it was necessary to compute the expected quit rate for PTOs--expected, as a function of experience--to use as a baseline when comparing PTO quit rates to economic conditions.

In Table 15, five PTO cohorts are followed through their careers at Seattle Metro, and the relationship between PTO quit rates and the general economic condition in Seattle, as measured by its unemployment rate, is demonstrated. Each row is the time path of one cohort. The numbers in the row are Actual Quit Rate - Expected Quit Rate, where expected quit rate was computed from the average career path of all the PTOs at this agency, and the quit rate is expressed as a function of experience. A minus sign in the table means that the driver cohort has had less attrition than might be expected on the basis of experience alone; a plus sign means that the cohort has had greater attrition than would be expected, given their level of experience. The results in Table 15 provide evidence that many PTOs are only marking time until FT work becomes available somewhere. It indicates that PTO quit rates increase during boom times (when, presumably, it is easier to find FT work somewhere outside the transit agency); and that PTO quit rates decrease during recessions, when outside opportunities are reduced. Clearly, quit rates are inversely related to economic conditions,

**TABLE 15 Analysis of How PTO Quit Rates Are Affected by Economic Conditions**

| | Year Hired | | | | | |
|---|---|---|---|---|---|---|
| | 1979[b] | 1980 | 1981 | 1982 | 1983 | 1984 |
| Unemployment condition[a] | Steady | Steady | Rising | Rising | Falling | Falling |
| | Hired | +2.0' | +1.1' | -0.4* | | |
| | | Hired | -2.0* | -4.2* | -0.9' | |
| | | | Hired | -7.6* | 0.0 | +1.2* |
| | | | | Hired | +0.7* | +3.1* |
| | | | | | Hired | +7.2* |

Note: * = supports hypothesis, and ' = contradicts hypothesis. Sum of confirming deviations = 26.4. Sum of contradictory deviations = 4.0.

[a] Data in the first row indicate unemployment conditions during that year, for example, "Rising" means that the unemployment rate increased during that year.

[b] For each cohort of PTOs, the column gives year hired, and the subsequent quit rate compared with the experience-standardized rate.

and many of the drivers actually wanted some other type of work.

## SUMMARY OF RESULTS AND SUPPORTING EVIDENCE

Five conclusions are presented. The first two are strongly supported by the data. The last three conclusions are supported by more limited data, typically involving only one or two agencies.

### PT Work Has Inherently Lower Absenteeism

PTOs have lower sick rates than do FTOs; this result was found across a wide variety of situations. Furthermore, the conclusion held even when PTOs and FTOs received identical sick pay benefits, whether the benefits were identically high or identically low: (a) when both PTOs and FTOs receive paid sick leave, the FTOs have higher absenteeism; and (b) when neither PTOs nor FTOs receive paid sick leave, the FTOs have higher absenteeism. The same conclusion was reached by tracing an identical cohort of drivers who moved from FT to PT status. The same conclusion was also reached when the effects of probation on the behavior of PTOs were factored out.

### Increases in Sick Pay Benefits Cause an Increase in Absenteeism

Even though the differences in sick pay between PTOs and FTOs are not sufficient to explain the difference in absenteeism, it was found that sick pay does matter. Specifically it was found that increases in the amount of paid sick leave available to an operator cause an increase in observed absenteeism. This result was found for FTOs when comparing those with sick pay to those without. This result was also found for PTOs when comparing those with sick pay to those without. Finally, this same result was found when the sick rates of FTOs were tracked over time as they moved into jobs with higher amounts of paid sick leave. In quantitative terms, it was found that successive increases in sick pay--from 0 days, to 3 days, to 5.2 days, to 12 days per year--were associated with successive increases in the observed rate of sickness.

### PTO Accident Rates Are Approximately Similar to FTO Rates

This is confirmed in the rough, unstandardized data at all the agencies. Only one agency provided sufficient data to fully standardize for differences in driving exposure between PTOs and FTOs. At that agency, holding constant hours of driving, years of experience, and the daily time pattern of accident hazards, it was found that PTOs had lower accident rates than did FTOs.

### Irregular Work Causes Increases in Absenteeism and Accidents

This is supported by data from a single transit agency, but it is the theoretically expected relationship.

### There Is a Tendency To Hire the Wrong People for PT Work

First, casual estimates from managers or unions at all five agencies indicate that 70 to 85 percent of the PTOs actually want FT work. Second, at one agency with detailed data available, PTO quit rates increase when more jobs are available outside the transit industry, and they decrease when area unemployment increases. The consequences of hiring the wrong PTOs are varied. Higher attrition produces higher training costs but lower average wages for PTOs; this is because new PTOs are constantly coming in at the beginning of the wage progression. Higher attrition also produces higher accident costs because a higher proportion of the PTOs will be on the low-experience portion of the accident curve. (This does not contradict the third conclusion; experienced PTOs will have even lower rates than the average PTO.)

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