(change in level of service) has a greater effect on revenue (ridership) than an equivalent percentage change in fares.

4. The effectiveness of a fare increase in producing increased revenue decreases with the time elapsed since the increase. It appears that transit riders need some time after the fare increase before they can switch to other transportation modes or eliminate certain unessential trips or both.

5. An overall revenue increase may be a sufficient parameter for financial and budgetary purposes. However, in view of the role of public transit in today's society, we need a better understanding of the effect of transit fare increases on different socioeconomic and demographic groups.

6. The models are not suitable for estimation of revenue or ridership changes in the absence of a significant fare increase. An extrapolation of historical trends will probably yield better results. The models are also unsuitable for estimating revenue or ridership changes brought about by only a small change in vehicle kilometers. Better estimates of future revenue or ridership changes may be obtained by specific analysis of routes, time periods, and reasons for which the distance changes are planned.

7. For long-term use the models presented in this report should be checked and updated periodically.

REFERENCES

1. A. J. Ugge and P. M. Dalton. Urban Transit Fare Increase Effects on Ridership in Ontario Cities. Systems Research and Development Branch, Ontario Ministry of Transportation and Communications, Downsview, Internal Rept., Feb. 1977, pp. 1-22.
2. J. F. Curtin. Effects of Fares on Transit Riding. HRB, Highway Research Record 213, 1968, pp. 8-18.
3. Employment Earnings and Hours. Statistics Canada, Labour Division, Ottawa, Catalogue 72-002, Vol. 55, No. 10, Oct. 1977.
4. The Labour Force. Statistics Canada, Labour Division, Ottawa, Catalogue 71-001, Jan. 1978.
5. M. Ezekiel and K. A. Fox. Methods of Correlation and Regression Analysis. 3rd Ed. Wiley, New York, 1959, pp. 293-299.
6. R. L. Carstens. A Model for Estimating Transit Usage in Cities in Iowa. HRB, Highway Research Record 213, 1968, pp. 42-49.
7. Y. Chan and F. L. Ou. Tabulating Demand Elasticities for Urban Travel Forecasting. TRB, Transportation Research Record 673, 1978, pp. 40-46.
8. W. Lassow. Effect of the Fare Increase of July 1966 on the Number of Passengers Carried on the New York City Transit System. HRB, Highway Research Record 213, 1968, pp. 1-7.

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

Abridgment

Who Pays the Highest and the Lowest Per-Kilometer Transit Fares

Wayne R. Ugolik, New York State Department of Transportation, Albany
Clark B. Leutze, State University of New York at Albany

Most U.S. transit systems charge a basic flat fare for bus trips within large zones surrounding urban centers, and additional incremental charges for longer intercity and intraurban bus trips. Naturally, under such fare structures, fares per kilometer for transit users vary greatly as trips differ in length. But, since such differences are often correlated with differences in rider characteristics, the issue of the equity of such fare structures has recently come into focus (1-3), particularly in light of transit-operating subsidies. The concept of distance-based fare structures has been proposed as a means to increase ridership and revenues while equalizing fares per kilometer across all transit users (4, 5). Therefore, the issue of fare equity needs to be considered by transportation planning professionals.

This paper takes a close look at fare equity, from the standpoint of the transit user, by investigating fares per kilometer paid by different groups of bus riders.

STUDY AREA

The research consisted of an examination of the ridership profile of the transit system operating in the capital district of Albany, New York, an area comprising three medium-sized cities within a radius of about 16 km (10 miles)

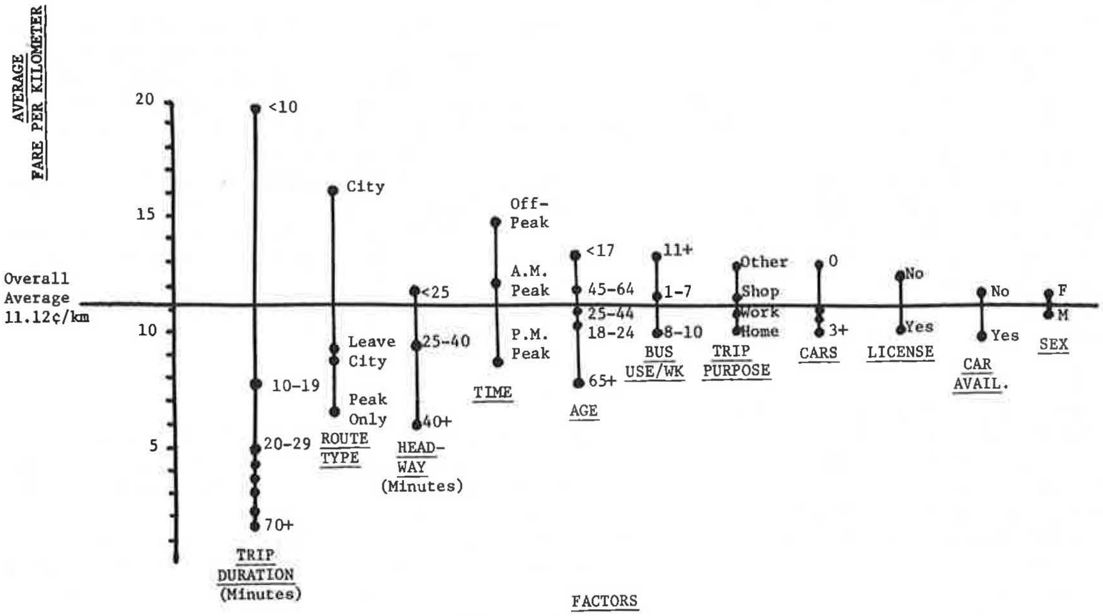
The fare structure is a basic flat rate. Riders within the urban centers pay 40 cents plus additional increments up to a maximum fare of 75 cents for intercity and intraurban bus trips. It should be noted that there are half-fare rates available to senior citizens and handicapped persons and special discount commuter and school passes.

The data base consisted of coded responses to questionnaires distributed during an on-board survey conducted in November 1975. More than 1100 questionnaires were analyzed; an average of 43 300 one-way trips are made daily on the system. Each questionnaire is related to one bus trip. Using information asked of the respondents concerning origin, destination, and fare paid, the fare per kilometer and the trip duration (in minutes) for each bus trip were calculated.

DIFFERENCES IN AVERAGE FARES PER KILOMETER

The average fare per kilometer for all riders in the sample was 11 cents/km (18 cents/mile) with a standard

Figure 1. Differences in average fares per kilometer.



deviation of nearly 9 cents/km (15 cents/mile). There is obviously a great deal of variation in fares per kilometer paid by different transit users. Some riders are getting a very good bargain; others are not. By analyzing the survey data on the average fares per kilometer for different classes of riders and types of trips, the study showed who these people are.

Figure 1 illustrates the differences in average fares per kilometer paid by different groups of riders. The groups determined by the factor trip duration show the greatest spread in average fares per kilometer. One-third of all riders traveled less than 10 min on the bus and averaged 20 cents/km (32 cents/mile). The next group, composed of riders who traveled between 10 and 20 min on the bus (42 percent of the sample), had an average fare per kilometer of only 8 cents (13 cents/mile).

Interestingly, about 10 percent of the riders traveled over 30 min on the bus and averaged less than 4 cents/km (7 cents/mile). These are the people traveling on intercity and intraurban bus routes. Comparison of their average fares per kilometer with those of people traveling less than 10 min on the bus shows clearly that basically flat-fare structures skew fares per kilometer in favor of the longer-distance traveler.

A look at average fares per kilometer on different types of bus routes indicates further that those who travel farther receive the greatest bargain. Indeed, riders traveling within the city centers (25 percent) pay an average fare per kilometer of 16 cents (26 cents/mile), which is more than 6 cents higher than that of the riders traveling on intercity routes (26 percent) or routes that leave the city limits (24 percent). Moreover, 7 percent of the sample rode on special peak-hour work-trip routes and averaged paying less than 7 cents/km (11 cents/mile).

In light of the fact that bus routes that reach into the suburbs have longer headways than inner city routes, it is of interest that on routes with headways of more than 40 min, fares per kilometer averaged 6 cents less than on routes with headways less than 25 min. This indicates that suburban riders receive a far better per-kilometer bargain than inner city riders, mainly because they must travel farther to reach centers of business and employment.

A study of the time the bus trips were made showed that midday off-peak riders (28 percent) averaged a fare per kilometer of over 13 cents (21 cents/mile), which is nearly 5 cents (8 cents/mile) higher than the average fare per kilometer paid by afternoon peak-hour riders. The latter group most likely comprises riders returning home from work. Interestingly, morning peak-hour riders paid an average fare per kilometer 1 cent above the overall average of 11 cents. This is due to the fact that, during the morning hours, some riders are using the bus for nonwork, personal business and school trip purposes, since work trips (37 percent) averaged 11 cents/km (17 cents/mile), while nonwork, nonshopping trips (24 percent) averaged 13 cents/km (21 cents/mile). All shopping trips (6 percent) averaged 11 cents/km (18 cents/mile).

Analysis of the ages of the bus riders showed that those under 18 years of age (15 percent) averaged the highest fare per kilometer, 17 cents (27 cents/mile). People over 65 (6 percent) averaged the lowest fare per kilometer, 8 cents (13 cents/mile), because they paid the special half-fares offered to the elderly. Discarding these extremes, it is noteworthy that, as age increases, average fare per kilometer tends to increase.

More interesting, however, is the fact that the study showed no appreciable difference between the average fare per kilometer paid by men and women. Indeed, even though women riders (68 percent) greatly outnumbered men riders, the average fare per kilometer for women was 11.3 cents (18 cents/mile), while that for men was 10.8 cents, a difference of only half a cent.

Intimately connected with bus use is the concept of need for the bus. Clearly, people who do not have cars available for use need the bus more than those who do have available cars. The riders who had cars available (21 percent) averaged a fare per kilometer of 9.6 cents (15.4 cents/mile); those without averaged 11.6 cents (18.6 cents/mile). Moreover, riders without valid driver's licenses (51 percent) averaged 12.2 cents/km (19.6 cents/mile), while those with them averaged only 10 cents/km (16.1 cents/mile).

Average fares per kilometer decrease with the number of cars in the rider's household. Indeed, 31 percent of all riders had no cars in their households and averaged 13 cents/km (20 cents/mile), while 26 percent of the riders had two or more household cars and averaged less than 10.3 cents/km (16.5 cents/mile) for their bus trips.

A look at the factor average weekly bus use shows that riders who used the bus 8-10 times per week (40 percent) averaged only 10 cents/km (16 cents/mile), but those who used the bus 11 or more times per week (18 percent) averaged over 13 cents/km (21 cents/mile). The latter group is people who must regularly use the bus for most if not all of their transportation needs, whereas the former group is regular work-to-home commuters. Thus, there is strong and consistent evidence that people who need the bus most must pay the highest fares per kilometer.

The relationship between fare per kilometer and frequency of bus use has been studied in relation to the economics of demand (6). Results show that frequency of use is highly inelastic with respect to fare per kilometer, which implies that need plays a larger role than out-of-pocket cost in the process of deciding to use the bus. This, together with the results of this paper, suggests that the distribution of fares per kilometer is most unfair; those adversely affected are generally unable to use transit selectively and must use the bus as the only means of transportation available to them.

In addition to studying average fares per kilometer for different classes of transit users, a computerized data analysis scheme called automatic interaction detection (AID) was used to determine which factors explained the most variation in fares per kilometer (7). The results of this analysis were consistent with the picture of the variations in average fares per kilometer presented in Figure 1.

Indeed, the figure indicates large differences between the average fares per kilometer of groups of riders defined by trip duration, route type, and bus headway. These were the same factors that best explained the variation in fares per kilometer (57 percent explained); the factor trip duration explained the most variation (38 percent). None of the other factors proved effective in explaining the remaining variation. This is due to the interrelations among many of them; for example, the variation explained by work trips is explained by trips of longer duration, since work trips tend to be longer trips.

SUMMARY AND CONCLUSIONS

The research reported here showed that fares per kilometer vary greatly among different transit users and that, even when incremental fares are charged in addition to basic flat fares on longer intercity and intraurban routes, the fares per kilometer of bus trips tend to be inversely proportional to the length of bus trips.

Work-to-home trips cost less per kilometer than non-work-related trips; people without cars or unable to use cars pay higher fares per kilometer on the average than do those with cars available. The average fare per kilometer of peak-hour riders is less than that of off-peak riders.

In addition, it was found that there was no appreciable difference in fares per kilometer paid by men versus women but that there is a tendency for fares per kilometer to rise as age increases from 18 to 65. Thus, current basically flat-fare systems tend to emphasize inequities already existing in society.

A priori, distance-based fare structures would equalize fares per kilometer across all groups of transit users. Basic research has shown that such fare structures can also maintain ridership and revenue levels (8). Further research into practical ways to implement such fare structures is needed. A preliminary study may be found in Natalizio (9).

REFERENCES

1. D. L. Weiss, D. T. Hartgen, and G. S. Cohen. Equity in New York State Transit Fares. Planning Research Unit, New York State Department of Transportation, Albany, Oct. 1975.
2. D. L. Weiss and E. P. Donnelly. Characteristics of New York State Transit Users. Planning Research Unit, New York State Department of Transportation, Albany, Aug. 1976.
3. D. L. Weiss and D. T. Hartgen. Revenue, Ridership, and Equity of Differential Time-of-Day Fares. Planning Research Unit, New York State Department of Transportation, Albany, April 1976.
4. Peat, Marwick, and Mitchell. Public Transportation Fare Policy. Urban Mass Transportation Administration, U.S. Department of Transportation, May 1977.
5. Financing New York City's 1976 Transit Deficit. Planning Division, New York State Department of Transportation, Albany, Staff Rept., June 1975.
6. W. R. Ugolik. Demand Elasticities of Per Mile Transit Fares. Planning Research Unit, New York State Department of Transportation, Albany, Feb. 1978.
7. J. A. Sonquist and J. N. Morgan. The Detection of Interaction Effects. Survey Research Center, Institute for Social Research, Univ. of Michigan, Ann Arbor, Monograph 35, 1970.
8. D. P. Blou, D. T. Hartgen, and L. Mohan. Distance-Based Transit Fares: Robin Hood or Sheriff of Nottingham? Planning Research Unit, New York State Department of Transportation, Albany, Aug. 1978.
9. F. Natalizio. Study of the Implementation Issues of a Distance-Based Fare for the Albany Transit System. School of Business, State Univ. of New York, Albany, May 1978.

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