Forecasting Demand and Revenue for Transit Prepaid Pass and Fare Alternatives

Thomas E. Parody and Daniel Brand, Charles River Associates, Boston

This paper presents a relatively low-cost, easily implemented method for forecasting the demand and revenue impacts of alternative transit-fare prepayment (TFP) instruments and transit fares. In addition, alternative TFP strategies and their price implications are derived in some detail from basic TFP objectives. The forecasting technique focuses on computing price elasticities by individual market segments by using data from previous fare and service changes and then applying these results to forecast changes in the present transit system. The market segments are chosen to correspond with the issues being analyzed, thereby increasing the usefulness and accuracy of the procedure. To illustrate how the technique can be used to forecast the impacts of different monthly transit pass programs along with increases in transit fares, a case-study approach that uses local data from the Jacksonville, Florida, transit system was chosen. The data required in the analyses are typically available from most transit properties; therefore, the method is readily transferable to other areas.

This paper presents a method for forecasting ridership and revenue impacts of alternative transit-fare prepayment (TFP) instruments and transit fares. In addition, alternative TFP strategies and their price implications are derived in some detail from basic TFP objectives. The forecasting method uses demand elasticities derived from past changes in transit fare and supply for the system being studied. These elasticities are then used to project future patronage levels based on proposed changes in the TFP structure and fares on the present transit system.

In addition to being quickly and inexpensively implementable, the major advantage of this forecasting approach is its use of demand elasticities computed from prior changes in the same transit system rather than the more typical approach of transferring elasticities that have been observed elsewhere (either empirically or analytically through the use of models). This procedure greatly reduces the effect of numerous exogenous factors that vary from one locality to another and are normally not included in demand models or elasticity calculations. In particular, the approach automatically controls for the distribution of most socioeconomic variables (income, automobile ownership, etc.) and, to a large extent, many site-specific variables (geography, alternative transportation system characteristics, the particular structure of travel in the region, etc.) so that the same change in the transit system is being made and analyzed over different time periods.

To illustrate the method, a case-study approach is used with local data from the Jacksonville, Florida, Transportation Authority (JTA) transit system. As the data required are typically available from most transit properties, the approach is readily transferable to other areas.

Since 1970 the use of monthly transit passes by U.S. transit operators has been growing rapidly. A recent study of TFPs used by transit agencies in the United States has shown that, whereas only a few cities were using monthly passes as of 1970, 36 transit systems were using these passes in 1975 (1). Within the last year, monthly transit pass programs have begun in Dallas, Columbus (Ohio), Chicago, Sacramento, Houston, Hartford, Detroit, and Ann Arbor (2).

Currently, JTA is in the process of implementing an employer-based monthly transit pass program as part of a demonstration funded by the Urban Mass Transportation Administration (UMTA) under a service and methods demonstration program. Because of the growing use of this type of fare payment system, it is useful to analyze procedures for forecasting the ridership and revenue responses that can be expected from implementing a TFP program.

OVERVIEW OF THE JTA TRANSIT SYSTEM

As a prelude to analyzing the impacts of alternative TFP and fare strategies, this section describes some of the relevant characteristics of the JTA transit system at the time this study was performed. (After the study, base transit fares in Jacksonville were raised by 10 cents and changes were made in TFP structure and pricing.)

On July 15, 1970, before public acquisition of the transit system, adult bus fares were raised by 5 cents, from 25 to 30 cents. The before-and-after data from this fare change will be used to derive the price elasticities required for the later analyses. After the system was publicly acquired at the end of 1972, base adult fares were reduced back to 25 cents, where they were at the time of this study (early 1978).

JTA currently sells an unlimited-use weekly pass for $5.00. In addition to a contemplated change in the types of TFPs being sold, JTA is planning to increase the 25-cent base adult fare. The fact that this base fare is common both to the prior period for which elasticities are being calculated and to the present (or analysis) time period is an added advantage in the application of elasticities (particularly those computed on shrinkage ratios) because of their scale dependency (3). In addition, both periods involve a fare increase that entails breaking a single coin.

Although it is not well documented in the literature, some believe that any change in the fare structure requiring two or more coins will have an additional deleterious effect on demand over and above the effects of the fare change alone. If, in fact, breaking the quarter results in a larger than normal impact on demand, this effect will automatically be included in the elasticities computed.

To help understand the present patronage levels in Jacksonville, some knowledge of past changes in transit ridership statistics is useful. Figure 1 shows the trends in yearly ridership from 1962 to 1977. As can be observed, ridership was declining well before the 5-cent fare increase in 1970. Ridership started to increase in the period immediately after 1972 when the system started public operation, base adult fares were returned to 25 cents, and service was improved and expanded.

Figure 1. Trends in yearly ridership.

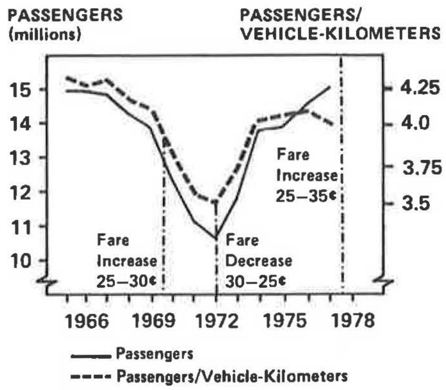
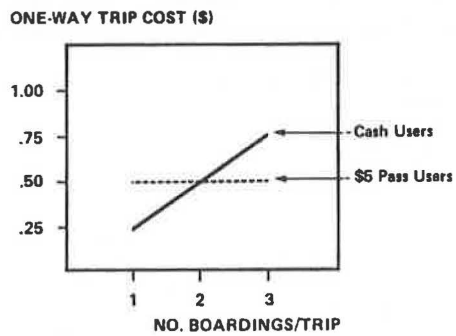


Figure 2. Fare structure.



As Figure 1 clearly shows, 1978 ridership returned to the levels enjoyed in the early 1960s.

DERIVATION OF TFP ALTERNATIVES

In the following sections, we shall identify the objectives of a TFP by using conditions in Jacksonville as an example. We shall then introduce and describe different types of passes designed to meet these objectives.

TFP Objectives in Jacksonville

A successful pass program must be attractive to both the user and the transit operator. Therefore, the following guidelines should be followed.

1. Under optimal conditions, a pass should be designed so that it is attractive to all users whether they transfer or not. This is particularly important in pricing the pass if many trips involve a separate transfer fare. If the pass is priced strictly on the basis of use by (paying) transfer passengers (e.g., at more than 20 round trips per month), then nontransferring riders will not find it attractive. Conversely, if an unlimited-use monthly pass is priced at less than 20 round trips per month, then the transit authority will be faced with a potential decrease in revenues from riders who previously paid for transfers but now use a pass. Solutions to the problem of appealing to two different user groups (transferring and nontransferring) for bus systems are presented below (passes 2 and 3).
2. TFPs should attempt to minimize both pass and coin-handling requirements. This suggests a monthly pass (versus weekly passes) and either no- or single-coin fares.
3. TFPs should allow individuals who must transfer to do so at reduced cost, i.e., less than another full fare, and with minimal increases in administrative and distributional expenses to the transit operator (for instance, by not employing transfer slips).
4. The design of a pass should include recognition and minimization of potential abuse or fare cheating.
5. The pass should be sold both to the general public and at employment sites. That is, a pass that may be introduced and sold at employment locations should also be sold to the public at the regular transit sales outlets. This will reduce potential distortions in pass-purchasing behavior caused by a black market in passes bought originally only at employment sites.
6. Given that the average family income of bus riders is about $9000 compared to $15 250 for the resident Jacksonville population (4, 5), it is desirable to keep the initial front-end cost of the pass at a minimum. That is, the advantages of a TFP to low-income riders should be available to those who cannot put much money together at one time to purchase the pass. This suggests that the purchase price of the TFP should be only part of the entire fare cost.

TFP Alternatives

This section analyzes the current bus pass sold in Jacksonville and then introduces two other TFP alternatives. The discussion is presented from the viewpoint of users who ride the regular 25-cent bus routes. The special services such as express flyer and 75-cent beach routes in Jacksonville are not considered here. Transfers are not offered at a reduced price in Jacksonville.

Figure 2 is useful for illustrating the current Jacksonville fare structure. Plotted is total one-way daily bus-trip fare and number of bus boardings per one-way trip assuming travel on 25-cent bus lines. Notice that the $5.00 weekly pass places an upper limit on the cost of regular trip making. That is, regardless of the number of transit-vehicle boardings required to complete a trip, the one-way trip cost to the user is typically limited to 50 cents, based on 20 round trips per month.

In terms of Figure 2, the following three passes will now be discussed and analyzed.

Pass 1. Existing weekly pass: The first type of pass to be considered is the existing unlimited, unrestricted weekly pass. This pass, priced at $5.00, is represented on Figure 2 as the horizontal dotted line intersecting the y-axis at 50 cents.

Pass 2. The 15-cent pass (or permit): The 15-cent pass (or permit) would sell for $6.00 a month (as compared to the present $5.00/week pass). All peak-period rides with this pass cost 10 cents. Off-peak rides could either be free or cost 10 cents, to be determined at the discretion of the transit authority.

If 20 round trips are made each month, then the user is paying an initial, or front-end, price of 15 cents for each trip. However, the payment of 10 cents for the first boarding of a trip results in an actual fare of 25 cents; a one-way trip involving two boardings (i.e., a single transfer) would cost another 10 cents for a total fare of 35 cents. This can be compared to the current 50-cent price of a transfer trip. The pecuniary characteristics of this pass are illustrated in Figure 3.

Pass 3. The 25-cent line pass: A 25-cent line pass selling for $10.00 a month would provide free travel on a specific bus line or sector of the city. Travel on all other lines (or in other sectors) would cost 10 cents with the pass. Off-peak rides are either free or cost 10 cents. As with the 15-cent pass, these are options to be con-

Figure 3. Characteristics of pass 2.

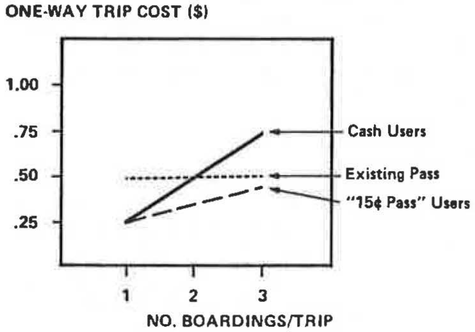
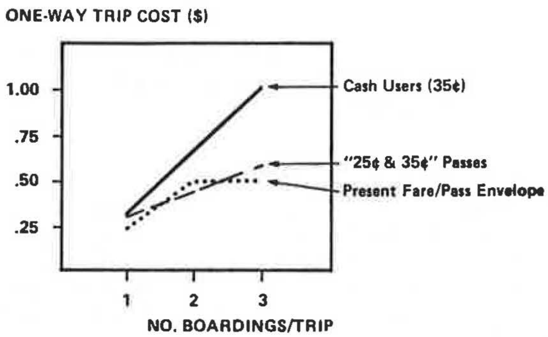


Figure 4. Fare integration after overall increase.



sidered. Assuming 20 round trips are taken per month with the line pass and all transfers are made to other lines, the graph of this pass is identical to that of the 15-cent pass shown above.

Discussion of Passes

An individual traveler would purchase the existing pass 1 only if he or she must transfer on a regular basis. Aside from its use on more costly lines, the effect of passes 2 or 3 (actually these could be labeled permits, but are called passes for simplicity) is to charge 25 cents for the first ride and 10 cents for each transfer, given the fares outlined above.

The second pass appeals to lower-income individuals, who tend to make more frequent transfers and who may not be able to afford a large outlay of funds for a pass at one time. Pass 3 appeals to the regular worker based in the central business district (CBD), i.e., the target individuals for a planned Jacksonville-UMTA joint TFP demonstration, who would like the convenience of a pass and the possible cost saving and can afford the higher initial price.

It is important to consider how these passes would be integrated with an overall fare increase. Assuming for this example that base fares were increased 10 cents, the price of the four passes would be $7.00, $10.00, and $14.00, respectively. Figure 4 illustrates these passes under this assumption.

Note that the effect of the 15- and 25-cent passes, now renamed the 25- and 35-cent passes, in conjunction with a possible 10-cent fare increase, would be to reduce the cost of a two-ride trip (one transfer) for the lower-income travelers from 50 cents at present to 45 cents, with the above fare increase. This could be an important selling point in overcoming resistance to a fare increase from an equity point of view. Notice also that the first ride always costs 35 cents, ignoring other possible TFP discounts.

Therefore, each pass appeals to its own separate market on the basis of the lump sum of money affordable, the appeal of no change-handling requirements, and the number of transfers required in daily trip making.

DERIVATION OF PRICE ELASTICITIES

In this section we shall derive the price elasticities, i.e., the percentage change in ridership resulting from a 1 percent change in fare, by using data associated with the July 1970 fare increase in Jacksonville.

These calculations are first performed by using average systemwide fare changes and total changes in ridership. Later, we shall window in on the data by computing price elasticities for selected market segments, including TFP users, to distinguish groups of users who may be more or less responsive to a change in the price and payment mechanism for transit.

Systemwide Analysis

As noted above, the base adult cash fare of 25 cents was increased by 5 cents to 30 cents in July 1970. However, average systemwide fares increased from 25 to 33 cents or by 26.9 percent (6). Below are the trends in systemwide ridership for the 12-month periods before and after the June 1970 fare increase.

End of 12-Month Period	No. of Riders	Ridership Change from Previous Year (%)
June 1968	14 686 571	-
June 1969	13 859 693	-5.6
June 1970	13 392 427	-3.4
June 1971	11 507 600	-14.1
June 1972	10 733 978	-6.7

To compute a fare elasticity from these data, we first determine the relative percentage change in ridership from the fare increase by taking the actual percentage change in ridership in the year following the fare increase and subtracting general secular changes by using the percentage change in ridership during the year before the fare increase. Using the shrinkage-ratio formula, fare elasticity (E_f) is computed as

$$E_f = \text{percentage change in ridership (relative)} \div \text{percentage change in fares} \quad (1)$$

In this example, the change in ridership for the 12-month period immediately following the fare increase was -14.1 percent. However, the general secular change in ridership that was occurring in the year before the fare increase, -3.4 percent, is deducted from this figure, and results in a net or relative -10.7 percent change in ridership. An average systemwide fare increase from 26 to 33 cents, based on revenue and ridership figures, represents a 26.9 percent increase in fares. Thus, the resultant elasticity is computed as

$$E_f = -10.7/+26.9 = -0.40 \quad (2)$$

If there were no other supply changes made during this period, the figure would represent a best estimate of systemwide elasticity. However, at the time of the fare increase, level of service as measured by bus kilometers operated was also decreasing. Consequently, attributing all of the passenger reduction to changes in the fare level results in an overestimation of the above systemwide fare elasticity. Fortunately, a large share of the bus-kilometer impact has already been accounted for by taking into consideration past secular changes in ridership.

However, because bus kilometers were decreasing more rapidly during the period after the fare increase, it will be more accurate to compute a bus service or supply elasticity also by using the Jacksonville data. This may be done by using ridership changes associated with bus-kilometer decreases for a period (1968-1969) just before the fare increase. This bus-service elasticity can then be used to net out the additional effects of service reductions occurring simultaneously with the 1970 fare increase.

During the time period 1968 to 1969 there was a 1.06 percent decrease in ridership associated with a 1.88 percent decrease in bus kilometers. The 1.06 percent ridership decrease is the remainder after adjusting the (greater) rider decrease to net out the effect of slight increases in certain fare categories that also occurred in 1968 (6). From this information, a bus-kilometer elasticity can be computed as

$$E_s = \text{percentage ridership/percentage bus kilometers} = -1.06/-1.88 = +0.56 \quad (3)$$

For comparative purposes, a study (7) that examined a cross section of bus-service elasticities in 17 cities reported a service elasticity of about +0.7 for Jacksonville. Therefore, +0.56 appears to be a reasonable estimate of the current bus-kilometer elasticity for Jacksonville.

From JTA operating data, bus kilometers declined 2.52 percent in the 12 months following the fare increase, compared to a reduction of 1.66 percent in the year before, leaving only a -0.86 percent change in bus kilometers to be considered further. The additional ridership reduction due to this amount can be calculated as 0.56 × -0.86 or -0.5 percent. Consequently, the previous fare elasticity should be reduced by this amount:

$$E_f = [-10.7 - (-0.5)]/26.9 = -0.38 \quad (4)$$

This fare elasticity of -0.38 appears to be the best estimate of how systemwide ridership responded to the 1970 increase in fares, other quantifiable transit supply changes having been taken into account.

There is some evidence that the actual ridership loss may be even less today, however. First, this elasticity is based on an era in urban bus transit when bus service in general—comfort, cleanliness, reliability—was declining. The period could not be characterized as having a plant and facilities as new and modern as they are today. Also, the cost of alternative transportation (the automobile) was certainly less at that time compared to the present.

Furthermore, recent experience has shown that a fare increase coupled with an intensive marketing campaign tends to reduce loss of ridership (8). Therefore, the estimate of -0.38 for a systemwide fare elasticity appears to be an upper limit or most conservative estimate for Jacksonville under today's conditions. An ongoing study of the recent fare increase in Jacksonville is documenting actual changes in ridership.

The above analysis of fare and service elasticities was based on average systemwide statistics. In the following sections we shall present an analysis of fare elasticities computed for different market segments.

If elasticities can be determined for categories of travelers, it is possible to obtain more accurate predictions of ridership and revenue impacts as well as to obtain incidence information (which segments of the population are affected more severely than others by a fare increase).

Weekly TFP Users

As noted before, TFPs were being sold in Jacksonville in 1970. As part of the 1970 fare increase, the price of the pass was increased from $4.95 to $5.75, or 16.16 percent. Use of the weekly pass declined by 2.28 percent after the fare increase, compared to an increase of 4.1 percent in the year before the fare increase. Considering a 12-month secular trend as before, this results in a price elasticity of

$$E_f = [-2.28 - (4.1)]/16.16 = -6.38/-16.16 = -0.39 \quad (5)$$

If the average net bus-kilometer effect of -0.5 percent is included in the analysis, the fare elasticity for pass users is reduced to

$$E_f = [-6.38 - (-0.5)]/16.16 = -0.36 \quad (6)$$

The sensitivity of pass users to changes in fares is observed to be somewhat less than that of the system as a whole. This is reasonable, because TFP users are more apt to use the system regularly for work trips, which have often been shown to be less sensitive to fare increases (9).

Adult Cash Users

As 57 percent of riders in 1970 were 25-cent cash-paying adults, they represent the largest single class of patrons. In the year following the fare increase, a decline of -9.7 percent was noted for this group of travelers, compared to a decline of only -2.9 percent in the year prior to the fare increase. The percentage increase in fare for these travelers was 5 ÷ 25 or +20 percent. This, including the one-year secular trend, results in a shrinkage ratio of

$$E_f = [-9.7 - (-2.9)]/20 = -6.8/20 = -0.34 \quad (7)$$

Including the systemwide bus-service elasticity of +0.56 and an approximate 0.5 percent ridership decrease from bus-service reductions results in a shrinkage ratio of

$$E_f = [-6.8 - (-0.5)]/20 = -0.31 \quad (8)$$

The resultant adult cash-fare elasticity of -0.31 is less in terms of sensitivity than the systemwide fare elasticity of -0.38. This is as it should be, since, on a relative basis, more of the adult 25-cent trips represent peak-hour work trips. As noted before, these trips are generally less sensitive to fare increases. This fare elasticity is also important in helping to determine the impact of peak-hour fares.

Summary of Elasticity Analysis

An analysis of the 1970 Jacksonville fare increase indicates an average systemwide fare elasticity of -0.38. The price elasticity for pass users was very near that observed for the entire system. For adult cash trips, which take a disproportionately large share of the peak-hour work trips, a fare elasticity of -0.31 was determined.

CONSEQUENCES OF ALTERNATIVE JACKSONVILLE FARE INCREASES

The fare and bus-kilometer elasticities calculated in the previous section are used below to predict the ridership and revenue consequences of alternative fare and TFP changes. The following section briefly examines alternative fare increases, while the remainder of the paper concentrates on analyzing the consequences of different TFP options.

Fare Alternatives

The fare alternatives to be investigated consist of (a) an all-day uniform fare increase of 5 and 10 cents; and (b) a peak-period fare increase of 10 or 15 cents with no increase in off-peak fares. Both are examined under the assumption that bus kilometers, or supply, remain constant and, alternatively, are increased approximately 6 percent during the next fiscal year (10).

All-Day Fare Increase

If a current annual ridership of 15 200 000 is a base and a range in systemwide fare elasticity is -0.3 to -0.4 based on the above derivation, an average fare increase of 5 cents would reduce ridership by 6-8 percent (5/25 × 0.3 or 0.4), while system revenue increased by about $395 000 to $486 000. Similarly, a 10-cent average systemwide fare increase would decrease patronage between 12 and 16 percent and increase revenue by $670 000-880 000. This result assumes no change in bus kilometers.

If bus kilometers are increased by approximately 6 percent during the next fiscal year (10), the number of new patrons and additional revenue are estimated by using a bus-service elasticity of +0.7. This differs slightly from the bus-service elasticity of +0.56 calculated above for reasons beyond our purpose in this paper of illustrating the methodology described.

Thus, a 6 percent expansion in bus kilometers would increase ridership by 4.2 percent. Assuming 15.2 million annual riders, this results in approximately 638 400 new riders or $159 600 in new revenue, given present fares. Similarly, increasing bus kilometers by 6 percent while increasing fares 5 cents on an average would increase revenue from $174 000 to $180 000.

For an average 10-cent fare increase, the additional revenue from increasing bus kilometers would range between $187 200 and $196 627. Consequently, the revised revenue forecasted for a 10-cent fare increase would be $857 000-$1 077 000.

Increasing Peak-Period Fares Only

The basic economic argument for higher peak-period fares is that much of the labor and capital costs required to operate the system are needed to accommodate the disproportionately large loads during the morning and evening rush hours. As a consequence, the marginal cost of providing transit service in the off-peak is low. Therefore, users should be charged less to travel at this time.

If peak-period pricing provides an incentive for some users to switch their travel to the off-peak or to not travel by transit and thereby flatten the peak, then savings in vehicle and labor costs may be possible.

For a systemwide fare-elasticity range of -0.3 to -0.4, assumed to be equivalent to a peak fare-elasticity range of -0.2 to -0.3, increasing only the peak-period (7-9 a.m. and 4-6 p.m.) fares by 10 cents will increase revenue by $397 000-$492 000. In addition, if bus kilometers are increased by 6 percent, revenue will further increase by $176 000-$180 000 for a total increase of $573 000-$672 000. This is based on the observed peak to off-peak split of Jacksonville riders of 45 percent to 55 percent (6).

If average peak-period fares were increased to 40 cents and bus kilometers were held constant, fare-box revenues would increase $534 000-$698 000. A 6 percent bus-kilometer increase would increase these revenues by an additional $182 000-$189 000 for a total increase of $716 000-$887 000. Estimating the potential savings in operating costs that could accrue from switching of work-purpose transit trips from the peak period to the off-peak period (i.e., peak flattening) is beyond the scope of this paper.

Also, because of a very low time-of-day elasticity for nonwork trips, a negligible amount of discretionary or nonwork travel would be switched from peak period to the off-peak period (11).

The table below presents a summary of the ridership and revenue consequences for the alternatives discussed so far.

Alternative	Ridership Decrease (%)	Revenue Increase ($000)
Fare increase with increase in bus kilometers		
5 cents all day	2-4	571-666
10 cents all day	8-12	857-1077
10 cents peak period only	0-2	573-672
15 cents peak period only	2-4	716-887
Fare increase without increase in bus kilometers		
5 cents all day	6-8	395-486
10 cents all day	12-16	670-880
10 cents peak period only	4-6	397-492
15 cents peak period only	6-8	534-698

CONSEQUENCES OF ALTERNATIVE TFPs FOR JACKSONVILLE

In the following sections, the TFP alternatives presented above will be analyzed with and without a potential fare increase to derive the revenue implications of the various TFPs.

Existing Weekly Pass 1 (No Fare Increase)

By using the following pass-user types, or market segments, and the existing pass prices in Jacksonville in 1978, the revenues from present weekly pass sales (pass 1) are provided (see the table below).

User Type	No. of Passes Sold	Weekly Price ($)	Weekly Revenue ($)
25-cent transfer	710	5.00	3550
Beach	404	5.00	2020
Flyer	200	5.00	1000
Senior citizen	338	2.50	845
Student	483	2.50	1208
Total	2135		8622.50

Introduction of Passes 2 and 3 Without Fare Increase

In this section we forecast the impact of introducing the 15- and 25-cent pass, assuming no increase in base fares. The flyer and beach pass are increased by $10.00 and

Table 1. Revenue changes with passes 2 and 3 without fare increase.

User Type	New Total Monthly Fare ($)	Present Total Monthly Fare ($)	Fare Change (%)	No. of Passes Sold	Monthly Revenue ($)
25-cent transfer	14	21.67	-35	785	10 990
Beach	30	21.67	+38	358	10 740
Flyer	20	21.67	-7.7	205	4 100
Senior citizen	10	10.83	-7.7	346	3 460
Student	10	10.83	-7.7	494	4 940
Total					34 230

Table 2. Revenue changes with passes 2 and 3 with fare increase.

User Type	New Total Monthly Fare ($)	Present Total Monthly Fare ($)	Fare Change (%)	No. of Passes Sold	Monthly Revenue ($)
25-cent transfer	18	21.67	-16.9	746	13 428
Beach	42	21.67	+93.8	290	12 180
Flyer	28	21.67	+29.2	182	5 096
Senior citizen	14	10.83	+29.2	308	4 312
Student	14	10.83	+29.2	441	6 174
Total					41 190

$20.00, respectively, to account for the fact that these two services actually have fares of 50 and 75 cents, respectively, in Jacksonville. The validity of pass 1 for these services is considered a loophole to be corrected. Thus, the cost of pass 3 for beach users will be 75 cents × 2 × 20 = $30.00/month.

In making a forecast, the change in revenue per repriced pass and the change in pass sales from the price changes must be accounted for. That is, with regard to the latter, the number of transfer pass users will increase because trips with a transfer cost 35 cents for passes 2 and 3 versus 50 cents before (a 35 percent decrease), while the number of beach users will decrease (because of the perceived fare increase).

Table 1 can be used to determine the net change in pass revenue.

The fare-change column is based on comparing the new monthly pass cost in each category with what is currently charged (computed on a monthly basis). The number of passes sold by type is computed from the current number of passes sold (shown in the previous table) by using an average price elasticity of -0.3.

The analysis indicates that there is only a net $37 610, or 8 percent, loss in pass revenue, even though transferring passengers are receiving substantial fare reductions under the new TFPs (35 cents versus 50 cents). The additional revenue is generated by repricing the special transit services (flyer and beach runs). Adult cash-paying users are still charged 25 cents for transferring.

Revenue losses that do occur are attributable to the fact that the new passes are priced on the basis of four weeks to the month (20 round trips per month). Thus, when multiplying by 12 months to obtain a yearly figure, only a 48-week year is being used, versus a 52-week year with the current passes.

This, in itself, is a built-in reduction of 7.7 percent in the price of a pass and, consequently, revenues as shown in Table 1. It should be noted that pricing TFPs at 20 round trips per month or more or less than this number is a matter of policy. The consequences of such policy alternatives can be analyzed by the methods shown here.

Introduction of Passes 2 and 3 with a Fare Increase

Assuming a systemwide all-day fare increase of 10 cents, from 25 to 35 cents and an equal corresponding increase in the price of passes 2 and 3, the pass revenue shown in Table 2 would be generated.

The $494 280 yearly revenue from passes 2 and 3 represents an increase of $45 910 over what the current passes generate under the existing fare system. This is equivalent to a 10 percent increase in revenue from passes based on an overall 40 percent increase in fare (from 25 to 35 cents).

The table below presents in summary format the revenue consequences of the TFP alternatives analyzed above.

Alternative	Yearly Revenue (%)	Change in Revenue from Pass 1 $/Year	%
Pass 1 (existing $5.00 pass)	448 370	0	0
Passes 2 and 3 (current fares)	410 760	-37 610	-8.4
Passes 2 and 3 (35-cent base fare)	494 280	+45 910	+10.2

TFPs 2 and 3 are particularly attractive options when accompanied by a general overall fare increase, because most of the objectives associated with introducing a TFP, both in general and with respect to Jacksonville, are attained. These include appealing to different market segments (transferring and nontransferring passengers, and low-income riders not able to front large amounts of money), minimizing coin handling, and making off-peak use of the system more attractive.

CONCLUSIONS

By using relatively simple techniques that are easily applied and appropriate for many analyses of this type, this paper has presented a method that can be used to forecast the ridership and revenue consequences of alternative fare and TFP strategies.

The technique focuses on computing demand (fare and, if necessary, service) elasticities for individual market segments commensurate with the issues at hand, and on using these results in a straightforward manner to forecast changes in the existing transit system. Using elasticities derived in this way eliminates the substantial problems and uncertainties associated with transferring elasticities computed elsewhere.

Choosing additional market segments, which are bounded only by the available data, may improve the usefulness and accuracy of the results. For example, ridership changes on specific routes or corridors as a result of past fare and service changes may be used to analyze market segments served by those routes or served by specific types of services of interest such as rail, low-frequency bus, and express bus. Alternatively, the approach presented in this paper may be viewed as a screening of alternatives to be followed up with more expensive, more elaborate, and possibly more accurate models.

Finally, it may be hypothesized that the cumulative effect of many years of inflation may reduce the effect on ridership of a given percentage increase in fares over some constant or slowly rising, relatively low historical fare level. That is, fares and fare increases may contribute less to the overall travel-choice decision as inflation increases the current dollar value of time and other attributes of transit service. The extent to which this is the case is the subject of an ongoing study of a 10-cent fare increase in Jacksonville.

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The opinions and conclusions expressed in the paper are ours and do not necessarily reflect the views or policy of the Transportation Systems Center or the Jacksonville Transportation Authority.

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Abridgment

Feasibility of Combining Public Transit and School Bus System Services in Dade County, Florida

Michael J. Cooperman and Joseph A. Martin, Jr., Cresap, McCormick and Paget, Inc., Washington, D.C.
Fred J. Silverman, Dade County Office of Transportation Administration, Miami

The concept of a public transit system's providing school transportation services is an issue of major interest to many communities. Where a community already has two large transit operations—a general public transit operation and a school transit operation—there is a possibility that cost or service efficiencies or both can be achieved by using these services jointly. Several cities, such as Buffalo, Atlanta, and Toledo, have joint-use arrangements by which public school students are transported on the public transit system rather than by school buses.

At issue here is whether joint use would be appropriate for Dade County, Florida, which includes the city of Miami as well as other urban, suburban, and rural areas. Four alternatives for joint use of transit services were examined:

1. Home-to-school and return transportation of public school students by the public transit system, known as the Metropolitan Transit Agency (MTA),
2. Field-trip transportation of public school students by the MTA,
3. After-school transportation of public school students by the MTA, and
4. Maintenance of school-board buses by the MTA.

BACKGROUND

School-Board Transportation Services

Florida school boards are required by state statute to provide transportation services to students. They must provide home-to-school and return transportation for all public school students who live 3 km (2