Effects of Fare and Other Factors on Express Bus Ridership in a Medium-Sized Urban Area

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Ridership data for the express bus service in Knoxville, Tennessee, for the time period of September 1977 through August 1984 were analyzed to identify the effects of fare and other factors on transit usage. Most of the riders of the express bus service were employees of the Tennessee Valley Authority (TVA). The ridership data were adjusted for seasonal variation and fare was adjusted for inflation. A multiple regression analysis helped identify the significant independent variables. A model with the three independent variables of miles of travel, fare, and employment level was fairly accurate in predicting changes in daily ridership. The regression coefficients of the independent variables of the model were used to derive demand elasticity coefficients. The elasticity coefficient for fare, which was estimated to be –0.522, is higher than those revealed by other studies.

The purpose of this study is to quantify the effects of fare and other factors on express bus ridership in a medium-sized urban area. The Knoxville Transit's (K-TRANS) express bus ridership from January 1979 through August 1984 was used in developing a multiple regression model to explain the variations in ridership. Elasticity measures for each significant variable in the model were derived using the coefficients developed by regression analysis. The elasticities of transit use with respect to fare and vehicle miles of service are compared with those revealed by other studies.

HISTORY OF K-TRANS EXPRESS BUS SERVICE

Since December 1973, the Tennessee Valley Authority (TVA) and K-TRANS have held an agreement to encourage ridesharing in the city of Knoxville. At that time, K-TRANS began operating several express bus routes that were oriented to the TVA work schedule. Before October 1981, the agreement specified a minimum level of return for the express routes, and TVA was to pay any difference from this minimum if the collected revenue from fare fell below this level. TVA was also paying a 35 percent ticket discount to its employees. TVA's payment for meeting the guaranteed level of return averaged approximately $5,100 per month during the 12-month period before the discontinuation of the agreement in October 1981. In an attempt to regain lost revenue from the cancellation of the guaranteed payment, K-TRANS raised fares in October 1981. The subsidized ticket price increased from $0.585 to $0.845 for TVA employees. The previous fare increase had occurred only 7 months earlier in March 1981 when the discounted ticket price was raised from $0.4875 to $0.585. The price remained at the October 1981 level of $0.845 for TVA employees until July 1984 when K-TRANS lowered the discounted price to $0.65 in the hope of increasing ridership and revenue. Actual subsidized cost per ride in current dollars for TVA employees and the cost per ride in 1974 dollars are given in Table 1. The 1972 dollar cost is calculated by dividing fare by the urban consumer price index (CPIU).

TABLE 1 COST PER RIDE FOR TVA EMPLOYEES

Year	Quarter	Cost in Actual Dollars	Real Cost in 1972 Dollars
1979	1	0.3900	0.1884
	2	0.3900	0.1821
	3	0.3900	0.1763
	4	0.3900	0.1713
1980	1	0.3900	0.1649
	2	0.3900	0.1592
	3	0.4875	0.1952
	4	0.4875	0.1903
1981	1	0.4930	0.1875
	2	0.5850	0.2174
	3	0.5850	0.2113
	4	0.8450	0.3010
1982	1	0.8450	0.2985
	2	0.8450	0.2941
	3	0.8450	0.2886
	4	0.8450	0.2880
1983	1	0.8450	0.2881
	2	0.8450	0.2846
	3	0.8450	0.2812
	4	0.8450	0.2788
1984	1	0.8450	0.2758
	2	0.8450	0.2728
	3	0.6754	0.2163

Since the discontinuation of TVA's guarantee for minimum return, K-TRANS has attempted to minimize losses by eliminating underutilized express routes. In October 1981, K-TRANS operated 17 express bus routes. In August 1984, only 10 express routes were still in operation. The vehicle miles traveled declined by 41 percent between the third quarter of 1981 and the third quarter of 1983. The service levels are given in Table 2.

The average number of rides TVA employees made per day on the express buses decreased by 70 percent from January

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TABLE 2 NUMBER OF BUSES AND SERVICE MILES PER DAY

Year	Quarter	Number of Buses	Service Miles Per Day
1979	1	16.00	653.23
	2	16.00	664.00
	3	16.00	652.76
	4	16.00	655.45
1980	1	16.67	694.70
	2	17.00	708.41
	3	17.00	709.08
	4	17.00	698.61
1981	1	17.00	707.67
	2	17.00	703.00
	3	17.00	707.00
	4	16.00	666.17
1982	1	14.00	571.52
	2	14.00	588.00
	3	14.00	582.16
	4	12.00	509.00
1983	1	12.00	503.60
	2	11.33	452.18
	3	10.00	419.76
	4	10.00	422.44
1984	1	10.00	423.55
	2	10.00	423.96
	3	10.00	424.63

1979 to August 1984. In January 1979 the number of daily rides was approximately 1,100 as compared to 300 in August 1984. The decline in ridership may be attributed primarily to the fare increases and cuts in service. However, there are also several other factors that may have influenced ridership, which include the following:

- TVA employment in Knoxville,
- Vanpools,
- Cost of driving an automobile,
- Cost of riding a competitive bus service,
- Traffic congestion,
- Parking costs, and
- Adverse weather conditions.

It is obviously difficult to determine how much influence each of these variables has had on ridership. Regression analysis will be utilized to determine the relationship between ridership and some of the aforementioned variables.

MULTIPLE REGRESSION MODEL FOR ESTIMATING RIDERSHIP

One approach for analyzing variations in ridership is to analyze time-series data on transit patronage over a long period of time, 2 to 5 years, for example. Because the data in this case is gathered for a long period of time during which costs and income vary, fare should be examined in real terms; that is, fare should be adjusted by a price index such as the consumer price index. Adjustments for seasonal variations in ridership should be made also because ridership tends to fluctuate according to the time of year in a repeated pattern every year. After appropriate adjustments, the time-series data can be analyzed using the multiple regression technique.

The foregoing approach was adopted by Kemp (*1*) who developed a regression model using data for Atlanta to establish a relationship of transit ridership with fare and the amount of service. The model developed by this study is similar to Kemp's.

Regression Model Variables

Several variables were incorporated into the study to identify their effect on ridership. Each variable investigated for the regression model is discussed in the following sections.

The Dependent Variable

Bus ridership was used as the dependent variable and was defined as the total number of rides or one-way trips that are made in a designated time frame. The ridership data collected from K-TRANS represented the total number of express rides made during a month. The data were obtained by bus drivers by actual count of each person entering the buses. The ridership included a small percentage of nonTVA employees, and, therefore, an adjustment had to be made to obtain estimates of TVA employee ridership. For this purpose, TVA monthly express ticket deposits were divided by monthly express revenue to get the percentage of express revenue contributed by TVA employees each month. This percentage was multiplied by total express bus rides to get TVA employee rides, *RIDES*. To eliminate the influence of seasonal variation on the data, the time series ratio-to-moving average method was used to develop seasonal indices (*2*). Seven years of data, from September 1977 through August 1984, were used for this purpose. The seasonal indices, with a base value of 100, are given in Table 3.

TABLE 3 SEASONAL INDICES FOR TVA EXPRESS BUS RIDERSHIP

Month	Index	Month	Index
January	104.96	July	96.42
February	108.96	August	101.39
March	104.41	September	100.45
April	101.18	October	97.31
May	100.41	November	96.18
June	99.72	December	88.61

As shown by the seasonal indices, TVA ridership is highest in the month of February. This is probably due to inclement weather conditions. Ridership is lowest in December when many TVA employees take annual leave. The seasonally adjusted monthly ridership, *RIDESA*, was determined by dividing *RIDES* by the seasonal index and multiplying by 100. The seasonally adjusted daily ridership, *RIDESAD*, was calculated by dividing *RIDESA* by the number of working days, *DAYS*, in the month. *RIDESAD* is the dependent variable used in the regression model.

Independent Variables

Several independent variables were used in the regression analysis and are described as follows:

1. Bus fare—An inverse relationship between bus fare and ridership is expected. Fares were divided by the urban consumer price index to determine their value of 1972 constant dollars. This variable was labeled *FAREC.*

2. Number of express buses—Labeled *BUSES*, this variable indicated the magnitude of service and is expected to be directly related to ridership. (Each express route provided one inbound trip in the morning and one outbound trip in the afternoon.)

3. Express miles—The mileage covered by express buses per month, *MILES*, was estimated by the transit agency and included deadhead miles. The proportion of deadhead mileage with respect to total mileage remained fairly stable during the analysis period. As with the number of buses, mileage is an indicator of the service level and is expected to be related to ridership. *MILESD* represented the mileage covered per day and was calculated by dividing *MILES* by the number of service days in the month.

4. Knoxville employment—It was expected that TVA's employment and ridership would have a direct relationship because employment is the total pool from which riders are drawn. As the pool declines, the absolute number of rides is also expected to decline. The number of employees, *KNOXEMP*, represents the number of regular TVA employees in the downtown office who were eligible for purchasing the discounted ticket. The variation in the employment level from 1979 to 1984 is given in Table 4.

5. Number of vans—Although TVA has a policy of not assigning vans for vanpooling from areas where express bus services exist, questions have been raised by some concerned individuals and agencies regarding the impact of TVA vans on express bus ridership. The number of vans, *VANS*, represents the total number of vanpools commuting to the Knoxville area during the period. It is expected that the number of vans will adversely affect bus ridership because vanpools provide the convenience of door-to-door service.

6. Inches of snow—Although transit ridership was adjusted for seasonal variation, climatological data were collected for Knoxville to find out whether unusual variations in snowfall had an additional influence on ridership. It is believed that the number of inches of snow, *SNOWIN*, has a direct influence on bus ridership because many people who normally use cars or vans switch to buses on these days.

7. Trailways and bus fare—Trailways, a private company, operated an express bus route in an area in close proximity to K-TRANS express service in west Knoxville. In August 1980, Trailways doubled its fares 1 month after K-TRANS raised its fares. Ridership on K-TRANS buses increased during this period. Therefore, the fare data from the alternative bus service, *TRAIL*, was incorporated into the model. *TRAIL* was divided by *CPIU* to represent fares in real terms, *TRAILC*. It was expected that *TRAILC* would directly influence K-TRANS ridership.

8. Highway construction—A dummy variable was used to represent highway construction during the period of January 1980 through April 1982. There were considerable construction activities during that period and an inverse relationship between highway construction, *HWY*, and transit ridership is expected because of increased travel time for buses during this period. Buses were less flexible than cars and vans in altering routes to avoid congested areas during construction.

9. World's fair—A dummy variable, *EXPO*, was inserted to represent the 6-month period from May 1982 through October 1982 when the World's Fair was held in Knoxville. Bus ridership is expected to be directly related to *EXPO* because of increased congestion and parking costs in the central business district (CBD) during this period.

TABLE 4 TVA EMPLOYMENT LEVEL IN KNOXVILLE

Year	Quarter	Employment	Year	Quarter	Employment
1979	1	4,478	1982	1	5,370
	2	4,489		2	4,858
	3	4,554		3	4,671
	4	4,624		4	4,578
1980	1	4,711	1983	1	4,591
	2	4,867		2	4,639
	3	5,067		3	4,673
	4	5,198		4	4,671
1981	1	5,315	1984	1	4,657
	2	5,298		2	4,621
	3	5,324		3	4,531
	4	5,408			

Variable Relationship and Significance

A least-squares regression analysis including all independent variables discussed in the previous section was performed using the SAS Institute's (Cary, North Carolina) computer software package. The number of cases (the number of values of the dependent variable) used in the regression analysis was 68. The relationship of each independent variable with the dependent variable, whether or not any was significant at the 95 and 99 percent confidence levels, is given in Table 5.

The nature of relationship of all variables with respect to ridership, the dependent variable, was as expected. The only variables that were significant in the model were *FAREC*, *MILESD*, *BUSES*, and *KNOXEMP*. It should be noted that *MILESD* and *BUSES* were correlated with each other, and, therefore, both variables could not be included in the model at the same time. *MILESD* was chosen over *BUSES* because it more accurately represents the magnitude of service.

Note that the relationship of service miles with ridership is usually fairly clear in the case of a regular fixed-route transit service because service miles represent opportunities for using the service. In the case of TVA's express bus service, however, the relationship between these two variables was not exactly similar for several reasons. The express service had ample

TABLE 5 RELATIONSHIP AND SIGNIFICANCE OF VARIABLES

Independent Variable	Relationship with Ridership	Significant at 99%	Significant at 95%
FAREC	Inversely	Yes	Yes
MILESD	Directly	Yes	Yes
BUSES	Directly	Yes	Yes
KNOXEMP	Directly	Yes	Yes
VANS	Inversely	No	No
SNOWIN	Directly	No	No
TRAILC	Directly	No	No
HWY	Inversely	No	No
EXPO	Directly	No	No

opportunities for park-and-ride, and in some cases park-and-ride lots were served by multiple express routes. Thus the elimination of one express route did not necessarily remove all opportunities for riders to use express buses. Efforts were also made to capture some of the riders of discontinued routes by modifying the routing of other express buses.

Stepwise Regression

Stepwise regression was used to determine the best of one-, two-, three-, and four-variable models.

1. Single-variable model—The best single-variable model was with the independent variable *MILESD*, which yielded the following equation:

RIDESAD = −739 + 2.55 *MILESD*

The R-square value for this model is 0.901. It may be noted from the correlation matrix in Table 3 that the simple correlation coefficient (R) for the two variables *FAREC* and *RIDESAD* is −0.74854, which yields an R-square value of 0.56. Thus, a single-variable model, with *FAREC* as the only independent variable, would not have the explanatory ability of one with *MILESD*.

2. Two-variable model—*FAREC* and *MILESD* were the two variables selected for this model. The equation is

RIDE = −280 − 1088.74 *FAREC* + 2.21 *MILESD*

The R-square value for this equation is 0.919.

3. Three-variable model—The best three-variable combination included the variables *FAREC*, *MILESD*, and *KNOXEMP* and yielded the following equation:

RIDESAD = −623 − 1709.64 *FAREC* + 1.80 *MILESD* + 0.15 *KNOXEMP*

The R-square value for this equation is 0.932.

4. Four-variable model—The best four-variable combination included the variables *FAREC*, *MILESD*, *KNOXEMP*, and *VANS*, the resulting equation being

RIDESAD = −640 − 1404.62 *FAREC* + 1.65 *MILESD* + 0.20 *KNOXEMP* − 2.42 *VANS*

The R-square value for this model is 0.936.

Coefficient Stability

The coefficients in each of the models developed by the stepwise regression remained stable as variables were added. The following equations illustrate this:

1. *RIDESAD* = −739 + 2.55 *MILESD*,
2. *RIDESAD* = −280 − 1088.74 *FAREC* + 2.21 *MILESD*,
3. *RIDESAD* = −623 − 1709.64 *FAREC* + 1.80 *MILESD* + 0.15 *KNOXEMP*, and
4. *RIDESAD* = −640 − 1404.62 *FAREC* + 1.65 *MILESD* + 0.20 *KNOXEMP* − 2.42 *VANS*

As a new variable is added, the previous variable or variables selected remained significant and stable. This demonstrates that the model is rigorous. Also, no problem of multicollinearity between the independent variables appears to exist. To examine this further, the correlation matrix is analyzed.

Correlation Matrix

The correlation matrix given in Table 6 includes the significant independent variables and shows their correlation with the dependent variable and with each other. The relationship of the independent variables to each other does not show any strong correlations between any two variables. Therefore, there appears to be no problems of multicollinearity among independent variables.

TABLE 6 SIMPLE CORRELATION MATRIX

Variable	*RIDESAD*	*FAREC*	*KNOXEMP*	*MILESD*
RIDESAD	1.00000	−0.74854	0.48944	0.94915
FAREC	−0.74854	1.00000	0.01305	−0.68456
KNOXEMP	0.48944	0.01305	1.00000	0.49912
MILESD	0.94915	−0.68456	0.49912	1.00000

Prediction Accuracy of the Selected Model

The model selected for this study is the three-variable model represented as follows:

RIDESAD = −623 − 1709.64 *FAREC* + 1.80 *MILESD* + 0.15 *KNOXEMP*

This model was selected because all three variables are significant at the 99 percent confidence level. Furthermore, from the conceptual standpoint, the three independent variables complemented each other. *FAREC*, of course, is an important variable because its effect on changes of ridership is of major interest for this investigation. However, because *RIDESAD*, the dependent variable, is an aggregate measure of ridership, there is a need for an independent variable of aggregate nature reflecting the magnitude of service; *MILESD* served this purpose well. The independent variable *KNOXEMP* may be viewed as representing the density of TVA employees served by the express routes.

The difference between actual ridership and predicted ridership resulting from this model is shown in Figure 1. A particular case for which the application of the model would have been useful in predicting the impact of a fare change is discussed next.

In October 1981, the fare was increased from $0.585 per ride to $0.845 per ride. The CPIU for converting the 1981 fare to 1972 dollars is 2.799. In the preceding month of September, the seasonally adjusted actual ridership level was 1,048 and the number of miles per day that the buses traveled was 708. TVA employment level in Knoxville at the time was 5,342. If the transit manager planned to maintain a constant service level and expected the employment level to remain stable, the ridership level for October could have been predicted with the model as follows:

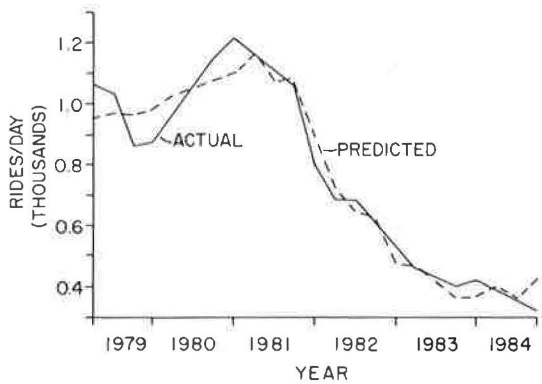

FIGURE 1 Actual ridership versus predicted ridership.

$$RIDESAD = -623 - 1709.64(0.845/2.799) + 1.80(708) + 0.15(5342) = 936.57$$

Because *RIDESAD* represents a seasonally adjusted figure, the actual ridership figure to be used for comparison should also be adjusted for seasonal variations. The actual seasonally adjusted ridership for October 1981 was 847.48, which is 89 rides less than the predicted number. This represents approximately a 10 percent error in estimation.

With reference to the situation in the preceding month of September, the model would have predicted a decrease in ridership by 10.6 percent accompanied with an increase in revenue of 29.1 percent. In actuality the ridership dropped by 19.1 percent and revenue increased by 16.7 percent.

ELASTICITY MEASURES

An alternative way to analyze changes in ridership is through elasticity measures. An elasticity measure, E, can indicate to transit managers how much influence a particular factor has on the ridership level. With reference to fare, the elasticity of demand is defined as the ratio of the percentage change in ridership to the percentage change in fare. In mathematical terms, this is expressed as

$$E = (dQ/Q)/(dF/F)$$

or,

$$E = (dQ/dF) \times (F/Q)$$

where E is the point elasticity of demand defined at the ridership level Q and the fare level F. In the formula, dQ and dF represent the derivatives (or incremental changes) of the respective variables—ridership and fare. The concept of point elasticity is difficult to apply to practical cases unless the changes in ridership (Q) and fare (F) are very small. In most cases, therefore, the concept of arc elasticity is used, which permits the use of average values of ridership (Q) and fare (F) based on their levels before and after a change occurs.

The elasticity measurement just discussed estimates the percent change in ridership for every 1 percent change in fare. A similar approach can be used to analyze relationships between ridership and other parameters also, such as service and employment levels.

In order to measure elasticity, an attempt must be made by the analyst to describe the response of a trip maker to a change in one factor at a time by holding other factors constant. The regression model presented in the earlier section can be used for this purpose.

Elasticity Coefficients

The regression model derived a coefficient, b_i, to describe the influence of each variable in the model. For each variable an elasticity measure can be derived if it is assumed that the other variables of the model remain constant. For example, to determine an elasticity measure for *FAREC* (F) from the regression model, it may be assumed that *MILESD* (M) and *KNOXEMP* (K) remain constant. The regression equation for estimating *RIDESAD* (Q) can be expressed in the following forms:

$$Q = a + b_F F + b_M M + b_K K$$

Therefore

$$dQ = b_F(dF) + b_M(dm) + b_K(dK)$$

If dM, the change in *MILESD*, and dK, the change in *KNOXEMP*, equal zero, then

$$dQ = b_F(dF)$$

or,

$$b_F = dQ/dF$$

By definition, fare elasticity is equal to

$$E_F = (dQ/dF) \times (F/Q)$$

Substituting b_F for (dQ/dF)

$$E_F = b_F \times (F/Q)$$

In the case of this analysis, the regression equation was developed using time-series data on each variable. The fare was adjusted based on urban consumer price index, and ridership also was adjusted to eliminate the effect of seasonal variations. Thus, the coefficients reflected the changes occurring during the analysis period, and the concept of arc elasticity is applicable to this case. Using the mean values of F (*FAREC*) and Q (*RIDESAD*) during the analysis period, as well as the regression coefficient of F (*FAREC*):

$$E_F = -1709.64(0.2356143)/771.56 = -0.522$$

The standard deviation was calculated using the t-value for the 99 percent confidence level at 64 degrees of freedom. Based on the standard error of $b_F = 315.96$:

$$E_F = -0.522 \pm 0.257$$

The elasticity measure and standard deviation for the other variables are as follows:

Elasticity coefficient for *MILESD*

$$E_M = 1.8(591.146)/771.56 = 1.38$$

Based on the standard error of $b_M = 0.1676$

$$E_M = 1.38 \pm 0.34$$

Elasticity coefficient for *KNOXEMP*

$$E_K = 0.15(4839)/771.56 = 0.941$$

Based on the standard error of $b_K = 0.043$

$$E_K = 0.941 \pm 0.716$$

Assessment of the Fare Elasticity Measure

In the past, the Simpson and Curtin (consulting firm) formula has been used widely in the transit industry for predicting the impact for fare changes. The formula predicts that transit ridership will increase (decrease) 0.3 percent for every 1 percent decrease (increase) in fare over their previous level (*3*). However, this rule of thumb may not pertain to every case because of differing elasticity measurements. Reasons for the differences are described in the following examples.

City Size

Small cities have higher fare elasticities than large cities. This is because small cities usually have less congested central business districts (CBDs) and lower parking costs. The mean all-hour fare elasticities for central cities of different sizes have been estimated for the following central city populations (*4*):

- Greater than 1 million—$E_F = -0.24 \pm 0.10$
- 500,000 to 1 million—$E_F = -0.30 \pm 0.12$
- Less than 500,000—$E_F = -0.35 \pm 0.12$

The city of Knoxville has a population of nearly 175,000 with the population of the metropolitan area being approximately 250,000. The CBD does not experience serious traffic congestion during rush hours. Monthly parking is available at prices ranging from \$20 to \$40.

In another analysis based on 28 cases, the aggregate fare elasticity and its standard deviation were estimated as -0.42 ± 0.24. These 28 cases included data from large cities such as New York, Chicago, Atlanta, and San Diego, and the data are for all hours of the day (*4*).

Peak Versus Off-Peak Travel

Most peak-hour trips are routine work trips; therefore, it is generally believed that peak-period travel is less responsive to fare changes. In almost every study where peak and off-peak fare elasticities have been estimated, off-peak elasticities are two to three times larger than peak travel (*4*). In a recent study of a 10 cents fare increase for the bus system in Mercer County in the Trenton, New Jersey, area, the fare elasticity of commuter travel was found to be −0.15, whereas that for noncommuter travel was −0.29 (*5*). The express buses in Knoxville catered to work trips during peak hours.

Captive and Choice Riders

Passengers who have an alternative mode of transportation are more responsive to fare changes than others and, therefore, they have a more elastic response to a fare change. Many of the express bus riders in Knoxville are choice riders. This is evidenced by the fact that many riders drive to park-and-ride lots to catch the buses.

Income Group

People in higher income groups may be expected to have larger fare elasticities than those of lower income groups. The majority of express bus riders in Knoxville earn incomes greater than \$15,000 per year.

Comparison of Fare Elasticity

The fare elasticity measure developed in this study for K-TRANS express buses is -0.522 ± 0.257 for TVA employees. This indicates that for every 1 percent change in fare, ridership will vary inversely by 0.522 percent. This value is higher than elasticity values developed in other areas. The larger elasticity value for the Knoxville area may be attributed to its smaller size, choice riders, an uncongested CBD with reasonable parking costs, and flexible working hours for TVA employees.

Assessment of the Service Elasticity Measure

The K-TRANS express bus service, as measured in terms of vehicle miles of travel by the buses, declined by 39 percent between November 1981 and June 1983. The number of buses (or bus routes) declined from 17 to 10 during this 18-month period. When a route was eliminated, an attempt was made to capture some of the former riders by adjusting and extending the existing routes. This resulted in longer travel times for many of the remaining routes. The estimated elasticity measure of 1.38 shows ridership to be elastic with respect to service cuts. This relatively high elasticity value may have resulted because of service cuts in vehicle miles, as well as increased travel times on the remaining routes. A few other studies investigated service elasticities resulting from expansions. Kemp analyzed time-series data for San Diego where service was expanded substantially over a 40-month period and found the elasticity to vary between 0.75 and 0.85 (*6*). In Atlanta, where service expansion occurred over a much shorter time period, Kemp estimated an elasticity with respect to vehicle miles of service of 0.30 (*1*).

SUMMARY AND CONCLUSION

The least-squares regression model derived to explain the variation in TVA employee ridership on K-TRANS express buses is

$$RIDESAD = -623 - 1709.64\ FAREC + 1.80\ MILESD + 0.15\ KNOXEMP$$

The R-square value for this equation is 0.932. All variables selected for this model are significant at the 99 percent confidence level. This model would be useful in predicting ridership changes and resulting revenue changes when fares or TVA employment in Knoxville change.

The demand elasticity measures (and standard deviation) with respect to each variable of the model are

$$E_F = -0.522 \pm 0.257$$
$$E_M = 1.38 \pm 0.34$$
$$E_K = 0.948 \pm 0.716$$

The elasticity measure for *FAREC* is slightly higher than those found in other studies. The elasticity coefficient for *MILESD* is considerably higher than those for other studies. No comparison was made for the elasticity with respect to employment.

It should be pointed out that the regression model and demand elasticities derived by this study may not be applicable to all cases of express bus service for commuters. The characteristics of TVA employees using the service, the size of the Knoxville urban area, and TVA's rideshare program for its employees are examples of background conditions that must be taken into consideration before deciding to transfer these results to another case.

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