Impact of Gasoline Price on Transit Ridership in Fort Worth, Texas

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(Reviewed by the Urban Transportation Division)

Abstract: The impact of gasoline price, gasoline supply, automobile ownership costs, and automobile operating costs on transit ridership is examined. Monthly data on transit ridership, gasoline supply, gasoline price, and consumer price indexes for automobile repair and maintenance, automobile insurance rates, motor oil, used cars, and automobile finance charges are all plotted to compare monthly, seasonal and yearly trends. The differences between the two energy shortages of 1974 and 1979 are analyzed, indicating that latent demand from by-choice transit riders for transit service exists in Fort Worth, Texas.

Introduction

The experimental method of research is difficult to use in the fields of transportation planning and urban planning for several reasons. Large numbers of humans are involved and individual humans are not always consistent in their response to a given stimulus. Groups of humans exercising free choice are at best only statistically homogeneous; thus, small scale experiments often have little transfer value. Experiments that involve denial or economic or psychic pain to the public, such as closing a freeway ramp to measure its effect on congestion, are usually not acceptable to free citizens. Therefore, most public transit experiments tend to be "addition-type," experiments e.g., increased frequency of service, newer equipment, and new route. "Addition-type" experiments are ill-suited to help transit managers answer such questions as: How much additional equipment does one need to order now so that capacity will be available to handle the increased ridership expected three years from now as the result of a predicted increase in gasoline price of 50%? If correctly analyzed, the data available from the energy short periods of 1973 and 1979 should help transit managers answer such questions.

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Objectives of this Research

The objectives of this research are to answer the following questions:

1. Is the concept of "Threshold Price" identified in previous research valid in Fort Worth?
2. Is transit ridership in Fort Worth significantly related to motor fuel supply?
3. Is transit ridership in Fort Worth significantly related to automobile costs?
4. How does the transit rider response in Fort Worth compare with the response in other cities?

The choice of mode of travel by an individual is obviously a complex one. No attempt is made in this paper to identify all the factors involved. This research was intended to investigate only a small part of the problem of transporting people and to identify and quantify a few of the significant variables.

Study Method

The method used in this research is to view the energy shortages of 1973 and 1979 as two separate "denial-type" experiments. Data were collected for the period from October, 1971–September, 1980 in order to include both periods. Several basic interrelationships between transit ridership, gasoline price, and automobile cost indicators on a month-by-month basis were analyzed for the entire nine-year period. A basic assumption is that the price increases were so large, the fuel supply reductions were so large, the events were so unexpected, and occurred in such a short time period that changes in all of the other factors affecting transit ridership were insignificant in comparison.

Fort Worth Transit System Profile

The Fort Worth transit system began in 1876 as the Fort Worth Street Railway Company. Many owners later, the transit system was acquired by the City of Fort Worth in 1972 and renamed CITRAN. A private management firm was then hired by contract to operate and manage the system. Since becoming a city-owned system, CITRAN has earned a reputation for efficiency, safety, and innovation. It has recently added 29 new RTS-II Advance Design buses to its fleet. The CITRAN route structure consists of 27 basic radial routes, four of which are express routes, plus one circumferential loop route. Five of the radial routes have two or more alternate paths of travel, resulting in a system comprised of a total of 34 possible service routes.

The 1970 census showed the City of Fort Worth to have just under 400,000 persons, constituting 51.6% of the population in its Standard Metropolitan Statistical Area. According to these census figures, 86.7% of the Fort Worth households had at least one car, 42.3% had two or more cars, and 17,301 households did not have a car. Only 1.34% of all urban trips were made by transit in 1970. An on-board survey of the CITRAN ridership indicated that the socio-economic profile was fairly typical of most transit systems in the United States with ridership predominantly composed of blacks, females, and elderly (most of whom

TABLE 1.—Socioeconomic Profile of Fort Worth Transit Riders

Group (1)	Ethnic group (2)	Group, as a percentage (3)	Total ridership, as a percentage (4)
Youth[a]			10
	minority	85	
	white	15	
Adult			84
	minority	63	
	white	37	
Elderly[b]			6
Total			100
	minority	43	
	white	57	
Ethnic group	black		58
	white		34
	Mexican-American		8
Total			100
Sex	male		39
	female		61
Total			100

[a]High School age or under.
[b]Age 65 or over.
Note: Source: Refs. 3 and 14, and CITRAN Ridership/Revenue Reports.

also represent low-income groups) and youth (14). As shown in Table 1, minority groups comprise approximately two-thirds of the ridership, yet 57% of the elderly passengers are white. Of all elderly persons (age 65 or over) in Fort Worth, 26.9% have incomes below the poverty level. A significant portion (19%) of the ridership is comprised of student riders (3). This student factor is important to recognize when analyzing the monthly fluctuations in ridership presented later in this paper. As can be seen from Table 1, 85% of the youth riders are members of minority groups. Although the white population comprises 80% of the Fort Worth population, only 34% of the transit riders are white.

Summary of Previous Research

Several studies have documented the impact of the 1973–74 energy crisis. One study conducted in a suburb of Columbia, South Carolina, concluded that the gasoline shortage did not affect appreciably the long-range transit patterns or the amount of travel but, rather, encouraged drivers to alter their driving behavior to conserve gasoline (11). Motorists preferred to limit weekend social-recreational trips, to drive slower, and to combine shopping trips with other trips rather than switching modes of transportation. Weekend traffic, particularly Sundays when only a few service stations were open, was down in some areas as much as 25%. A comparison of traffic volume and gasoline price changes between 1973 and 1974 is shown in Table 2. Arizona highway fuel consumption records

TABLE 2.—Response to 1973–74 Gasoline Price Changes

Months (1)	Years compared (2)	Urban, suburban, and rural traffic reduction, as a percentage (3)	Increase in 1974 versus 1973 gasoline price, as a percentage (4)
January	1974–73	−4.2	27
February	1974–73	−8.5	33
March	1974–73	−7.7	42
April	1974–73	−4.5	42
May	1974–73	−2.8	43

Note: Source: Ref. 12.

for January–February, 1974 showed an 11.8% reduction in gallons over the same period in 1973 (17).

There is evidence that many drivers were not convinced that the 1974 energy shortage was real. In one survey, more than 57% of the respondents indicated they felt the energy crisis was created (11). In a national survey, approx 30% of the car-owning households did not cut down on their driving at all during the peak period (January–February, 1974) of the shortage. When asked for the preferred solution if gasoline prices increased to 80 cents per gallon, drivers answered: "buy an economy car," "pay the increased price of gasoline," and "form a carpool," in that order (11). Increases in transit ridership were recorded, particularly between February 18 and March 15, 1974 when gasoline lines were longest, but receded in April, as gasoline lines dwindled (11).

In metropolitan Portland, Oregon, automobile owners were asked how the energy shortage changed their driving behavior (1). Of those interviewed, 52% indicated they made some behavioral change, including 26% who actually changed from cars to another transit mode. After the shortage, of those who had changed, 26% remained with the new pattern, 51% partially returned to their precrisis behavior, and 19% completely returned to their old habits. As could be expected, the socio-economic analysis revealed that the families most likely to stay with their new travel patterns were those with more family members, fewer cars, and lower incomes. Families more likely to simply reduce automobile use were of higher occupational status and had higher incomes. Families in the intermediate range with only a slight tendency to alter behavior were generally older residents of high occupational status, who had relatively few cars. The socio-economic analysis showed that the people hurt most by gasoline price increases tended to work as skilled craftsmen (or as skilled industrial workers), were more than 30 years old, had below-average educational levels, and earned less than $15,000 per year.

The concept of a "threshold" gasoline price was introduced in a survey of motorists in southeast Wisconsin (4). The question posed was how high the price of gasoline would have to go before a significant change in travel behavior would result. The survey was conducted in an era when the price was still below 60 cents per gallon. The critical threshold gasoline price then was determined to be approx 75 cents, a level which would prompt 69% of the households to change their driving behavior. According to one economic theory presented in a report

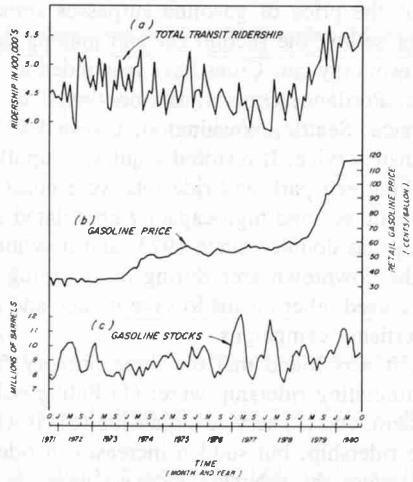
by R. L. Sansom, as the price of gasoline surpasses some threshold level, a family might consider selling the second car and making do with only one car or buying a smaller, economy car. Cities have responded to the energy shortages in a variety of ways. Portland, Oregon, has continued to keep fares low and provide frequent service. Seattle, Washington, invested $120 million in an attempt to improve transit service. It restored a quiet, nonpolluting 52-mile trackless trolley system. Fourteen park and ride lots were constructed, a downtown fare-free zone was instituted, and high-capacity articulated buses have been put into service. Ridership has doubled since 1973, and now almost one-half of the people traveling to the downtown area during the morning rush hour arrive by bus. Other cities have used other means to save money and attract transit riders, e.g., aggressive advertising campaigns.

In a recent study, it was found that the three primary factors that played a significant role in stimulating ridership were: (1) Public political support; (2) a financially stable system; and (3) service expansion (6). It was found that quality service may increase ridership, but sudden increases in ridership will not guarantee better service unless the ridership increase generates public support for financing the better service. Once public and financial support is obtained, service can be improved, thus, beginning an "upward cycle" in ridership, which ultimately has a multiplier effect on additional ridership increases. This upward cycle phenomenon has recently been experienced by the Champaign-Urbana (Illinois) Mass Transit District (6).

Data Collection

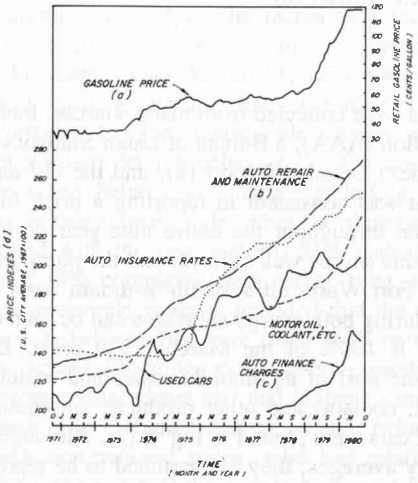
Gasoline price data were collected from many sources, including the American Automobile Association (AAA), a Bureau of Labor Statistics newsletter, the CPI (Consumer Price Index) Detailed Report (2), and the *Oil and Gas Journal* (9). The only source that was consistent in reporting a price for a predefined type and grade of gasoline throughout the entire nine-year period was the *Oil and Gas Journal*. Thus, this source was utilized, and the pump price for major brand regular gasoline for Fort Worth on a month-to-month basis is presented in Fig. 1. The price trends during both energy shortages can be seen clearly. The March, 1980 gasoline price is 180% of the March, 1979 price. Data for other price indicators, such as the cost of automobile repair and maintenance; automobile insurance; motor oil, coolant, and other products; automobile finance charges; and the price of used cars were plotted in Fig. 2 (2). Although these price indexes are United States city averages, they are assumed to be representative of similar price trends in the Fort Worth area. As can be seen from Fig. 3, the world price of oil more than doubled between January, 1979 and January, 1980, increasing from $13.77 per barrel to $28.55 per barrel (16). Retail gasoline pump prices were only months behind crude oil trends. Soon there were gasoline lines reminiscent of the first shortage. The 1979 domestic supply problems are clearly shown in Table 3, which shows the June, 1979 motor gasoline supply level of 7,160,000 barrels per day dropping below the average supply in 1977 of approx 7,180,000 barrels per day (13).

While the Gulf Coast region of the United States encountered two critical supply problems in May and November, 1979, as shown in Fig. 4, the nation



(a) TOTAL MONTHLY URBAN RIDERSHIP (INCLUDING ELDERLY, HANDICAPPED, STUDENTS AND TRANSFERS.)
(b) FORT WORTH PUMP PRICE OF MAJOR BRAND REGULAR; SOURCE: REF. (9)
(c) FOR INLAND TEXAS (INCLUDING REFINERIES, BULK TERMINALS, IN TRANSIT, AND IN PIPELINES.) SOURCE: REF. (8)

FIG. 1.—Monthly Trends in Transit Ridership, Gasoline Price, and Gasoline Supply



(a) FORT WORTH PUMP PRICE OF MAJOR BRAND REGULAR; SOURCE: REF. (9)
(b) INCLUDES WATER PUMP REPLACEMENT, TUNE UP, AUTOMATIC TRANSMISSION REPAIR, EXHAUST SYSTEM REPAIR, FRONT END ALIGNMENT, CHASSIS LUBE, BODY WORK, AND BRAKES.
(c) DECEMBER, 1977=100
(d) SOURCE: REF. (2)

FIG. 2.—Monthly Trends in Automobile Cost Indicators

as a whole experienced its one major supply shortage in November, 1979. Fig. 5 shows the seriousness of this shortage. The cross-hatched area represents the normal stock range, and is defined by the bounds of one standard deviation from the optimal inventory levels for efficient refinery operation and delivery of sup-

TABLE 3.—United States Domestic Motor Gasoline Supply (1973–79)

Date (1)	Supply[a] (1000's bbls./day) (2)
1973 (average)	6,674
1974 (average)	6,537
1975 (average)	6,675
1976 (average)	6,978
1977 (average)	7,177
1978 (average)	7,416
March, 1978	7,256
June, 1978	7,917
September, 1978	7,406
December, 1978	7,454
March, 1979	7,221
June, 1979	7,161

[a]Production plus net imports less net increase in primary stocks.
Note: Source: Ref. 13.

plies to consumers, as determined from past patterns. The dotted area represents the minimum acceptable level, or that inventory level at which spot shortages are probable. As inventories approach this level, as in November, 1979, the probability of refinery shutdowns and interruption in deliveries to consumers increases.

As gasoline shortages were developing nationwide, particularly in the larger cities, some states, such as California and Texas, were forced to implement gasoline ration plans. The Governor of Texas issued Executive Order WPC-74, "Establishing Guidelines for Motor Gasoline End-User Allocation," which established an odd-even license plate gasoline ration system to include Harris, Dallas, and Tarrant Counties which contain the cities of Houston, Dallas, and Fort Worth, respectively. This rationing plan, which went into effect June 25, 1979, was subsequently revised to include additional counties surrounding the aforementioned three counties, and was terminated on September 3, 1979.

During this period, major intercity passenger carriers were recording significant gains in ridership and revenues (8). Trailways, Inc., business was up 7–8% over the previous year. Amtrak set several records for ridership, and was receiving more advance bookings than during the 1973–1974 energy shortage. Nationwide, public transit systems were recording significant gains in ridership. Fifty-two of the 130 transit systems reporting to American Public Transit Association (APTA) recorded ridership levels of more than 10% above 1978 levels. Ridership was up 7,000,000 in Los Angeles, 4,000,000 in New York City, and 3,000,000 in Chicago (8).

The cost of automobile maintenance and repair was not susceptible to any major monthly fluctuations, but rather increased steadily at a rate comparable to the overall rate of inflation, as shown in Fig. 2 and Table 4. Automobile insurance rates increased rapidly between September, 1975 and September, 1976, taking a 32.6% jump. The prices of motor oil, coolant, and other products show two notable jumps, one during each energy shortage. The most recent surge in

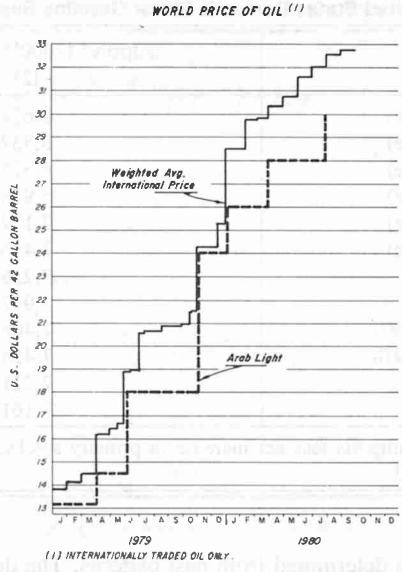


FIG. 3.—World Price of Oil (Ref. 16)

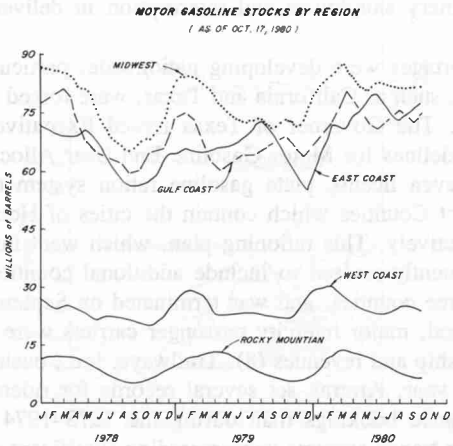


FIG. 4.—Motor Gasoline Stocks by Region (Ref. 16)

price amounted to an increase of 23.3% between July, 1979 and July, 1980.

One of the largest cost increases was for automobile finance charges. From May, 1979 to May, 1980, its price index increased 34.2%. The increase in the cost of automobile ownership had an effect on the used car market, which is clearly one of the most variable of automobile costs (Fig. 2). The prices of new cars and tires were considered to be less influential factors, increasing an average of only 6.6 and 5.6% per year, respectively, during the nine-year period, and,

TABLE 4.—Selected Price Increase Categories for the Nine-Year Study Period

Price category (1)	October, 1971 (2)	August, 1980 (3)	Increase (1971–80), as a percentage (4)
Fort Worth gasoline price	34¢	117¢	244.1
Fort Worth-Dallas consumer price index			
All items	122.5	257.4	110.1
Auto repairs and maintenance[a]	131.3	271.1	106.5
National consumer price index[a]			
All items	122.6	249.4	103.4
Motor oil, coolant, etc.[a]	121.7	232.7	91.2
Used cars[a]	111.7	206.4	84.8
Auto insurance rates[a]	141.8	250.2	76.4
New cars[a]	115.3	183.5	59.2
Tires[a]	117.6	177.3	50.8

[a]Consumer price index, United States City Average; Source: Ref. 2.

thus, were not plotted. A primary component of the automobile operating cost is the price of gasoline, which in 1975 constituted approx 25% of the average vehicle operating cost of 17.3 cents per mile for a standard-size automobile (12). Recent Hertz Rent-a-Car figures, as reported in a local newspaper, indicate a per mile cost of almost 50 cents for a full size car. With the end of federal price controls on motor gasoline, and, in view of the uncertain world gasoline supply conditions in the future, retail gasoline prices may reach $1.50–2.00 per gallon by the end of 1982 according to Department of Energy estimates made in late 1981.

Monthly transit ridership data for the nine-year study period were obtained from CITRAN, and are presented in Fig. 1 and Table 5. The monthly ridership

TABLE 5.—Average Monthly Transit Ridership in Fort Worth by Year

Fiscal year[a] (1)	Average monthly ridership (2)	Change from previous year, as a percentage (3)
1971–72	449,843	—
1972–73	468,252	4.1
1973–74	469,257	0.2
1974–75	447,233	−4.7
1975–76	456,458	2.1
1976–77	428,947	−6.0
1977–78	424,606	−0.9
1978–79	474,881	11.8
1979–80	535,468	12.8

[a]From October–September.

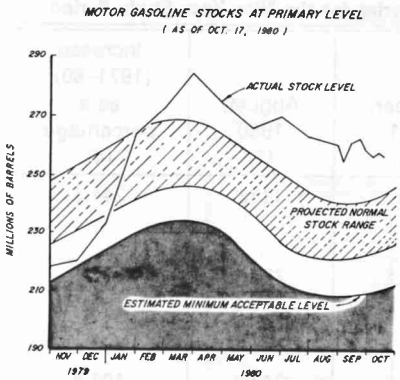


FIG. 5.—Motor Gasoline Stocks at Primary Level (Ref. 16)

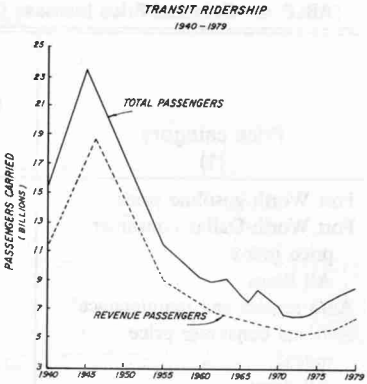


FIG. 6.—National Transit Ridership, 1940–1979 (Ref. 7)

trends are highly susceptible to seasonal variations, typically showing higher ridership in the spring and fall and lower ridership during the summer months. This is attributable in part to the fact that students comprise a significant share of the ridership, utilizing the transit system for the home-to-school trip.

In Fort Worth, transit ridership during 1974 actually declined from 1973 levels. Ridership did, however, make modest gains during April and May, 1974, increasing 5 and 4%, respectively, from the corresponding months in 1973.

CITRAN increased transit fares 14% in February, 1977, and in October, 1980, increased the basic fare again from 40–60 cents. Despite widely accepted observations that increased transit fares significantly reduce ridership, the October, 1980 average weekday ridership was down only 2.9%, a figure much lower than forecast (5,10). Total monthly revenue was $215,854, up 43.5% from October, 1979.

Also shown in Fig. 1 is a graph of motor gasoline stocks in in-land Texas. During 1977 and 1978, the seasonal variations in stocks appeared to be normal, with typically higher inventory levels between January and March and lower inventory levels between July and September. This conforms to normal national seasonal variations shown in Fig. 5. However, the lack of normally high gasoline stocks in the early months of 1974 and 1979, when supply interruptions occurred, is evident.

Nationwide transit trends are shown in Fig. 6.

Analysis

"Captive" riders are defined as those who have no automobile or other mode of transportation available except walking. "By-choice" riders are defined as all other transit riders.

It is assumed that prior to 1973 most, but not all, of the riders of CITRAN were captive riders. Captive riders are probably more sensitive to fare increases than any other factor identified in this study. Changes in fuel supply or price should not directly affect them at all. The data shows that Citran ridership after

the fare increase in February, 1977 did decline from the same period in 1976 as expected.

Ridership in general dropped off significantly in 1977 and 1978 when gasoline was free flowing and motorists had apparently forgotten about the first energy shortage. New records for ridership in recent CITRAN history were recorded in Fiscal Year 1979–1980, and noticeably absent are the off-season plunges in ridership characteristic of previous years. The changes in ridership after the 1980 fare increase in the data are probably mostly due to the loss of captive riders. Other than the fare increases mentioned there are no known events, such as an increase in unemployment of unskilled workers, during the study period which would affect the travel patterns of captive transit users. Therefore, all the increases in transit ridership are probably due to by-choice ridership changes.

A cross-correlation analysis of selected bus passenger characteristics indicated that, during the 1973–74 period of energy constraints, even though ridership gains were small and only temporary, bus lines that traversed areas with the highest average incomes; bus lines that provided the fastest service, i.e., the express lines; and bus lines that extended farthest into suburbs from the Central Business District (CBD) tended to experience the largest relative ridership increases (3). Further, there were high positive correlations between ridership increases and embargo-period passenger characteristics, such as having a car available, working in an office, having a driver's license, and having a family income over $10,000.

Except for the energy short periods, the moderate ridership increases since 1972 may be more a result of substantial transit-oriented federal legislation than a reflection of occurrences during the first energy shortage. This observation may be substantiated by noting that during 1973, the first year in which a transit ridership increase was recorded, energy supply problems did not develop until close to the end of the year.

The contraseasonal expansion of ridership in August, 1979 is almost certainly entirely due to increased numbers of by-choice riders whose incentive was the odd-even gasoline rationing plan in effect then. The ridership increases revealed in the data correspond closely in time to the gasoline price increases and other automobile-related cost indicators shown in Fig. 2 and listed in Table 6. It is likely these increases consist primarily of by-choice transit riders, since it is doubtful that the captive transit segment of ridership could experience an increase of this magnitude in such a short time frame.

The demographics of the transit system service area indicates that there are potentially large numbers of these by-choice transit riders.

The choice to change transport mode for making a regular trip may involve a substantial life style change. For instance, if a worker has to get up half an hour earlier, leave home half an hour earlier, get home half an hour later, and go to bed half an hour earlier in order to ride the bus to work each morning (rather than drive), then the worker may find that his children are still asleep when he leaves for work and that participation in evening activities, such as PTA meetings, is more difficult. It is unlikely that such major changes in lifestyle would be made if the fuel shortage or increased cost of auto travel were perceived to be short-term temporary events. The difference in citizen perception of events probably explains the different ridership changes in 1979–80 when compared to

TABLE 6.—Selected Price Increase Categories for Recent Critical 12-Month Periods

Price category (1)	Most critical period (2)	Price increase, as a percentage (4)
World price of oil[a]	January, 1979–January, 1980	107.3
Fort Worth gasoline price	March, 1979–March, 1980	80.0
Auto finance charges[b]	May, 1979–May, 1980	34.2
Motor oil, coolant, etc.[b]	July, 1979–July, 1980	23.3
Local transit fares[b]	August, 1979–August, 1980	22.9
Fort Worth-Dallas consumer price index		
All items	April, 1979–April, 1980	19.1[c]
National consumer price index[b]		
All items	April, 1979–April, 1980	14.7

[a]Weighted Average of Internationally Traded Oil Only (Fig. 1).
[b]Consumer price index, United States City Average; Source: Ref. 2.
[c]Highest among the 28 major urban areas regularly surveyed.

the 1973–74 changes. Although the first energy shortage created some short-term inconveniences, caused some temporary changes in travel patterns, and resulted in significant gasoline price increases, transit ridership was not affected appreciably, and motorists soon resumed their preshortage driving behavior. Gasoline supply rather than gasoline price appeared to be the primary determinant of travel habits in 1973–74.

The persistence of the ridership changes associated with the shortage of 1979–80 may be because the citizens perceive that a permanent change in the reliability of fuel supply and an increase in unit prices for auto travel has occurred.

For a visual comparison of ridership, gasoline price, and fuel availability during the study period see Fig. 1. Between January, 1979, and January, 1980, gasoline price increased approx 90% and transit ridership increased approx 23% in Fort Worth.

The data show that both the absolute change and percentage change in gasoline price associated with the 1979 shortage were much greater than similar changes in 1973–74. If the "threshold price" of gasoline for by-choice transit riders was not exceeded in 1973–74 but was exceeded in 1979–80, then one should expect large clearly discernable increases in transit ridership in 1970–80 and few, if any, changes in ridership in 1973–74. The data confirms the possible validity of the concept of "threshold price" for Fort Worth transit users.

Conclusions and Recommendations

The concept of "threshold price" of gasoline for by-choice transit riders, as identified in other studies (4), was tested in this study and found to be valid for Fort Worth transit riders. Transit ridership in Fort Worth is significantly related to motor fuel supply.

This study indicates that there is a strong correlation between gasoline price

and transit ridership, and, further, there exists, at present, latent demand of by-choice transit riders for transit service in Fort Worth. Change in motor fuel cost is the most significant factor affecting the modal choice of by-choice transit riders.

The ridership changes associated with the fuel shortage of 1973–74 were only temporary, confirming similar data from other cities contained in other studies (1,11).

While the first energy shortage of 1973–74 resulted in only temporary changes in travel patterns, there is evidence that the energy shortage of 1979–1980 has significantly altered public attitudes toward public transportation.

The demographics of the CITRAN service area reveal a large number of potential by-choice transit riders. Well-designed routes and service schedules might enable transit management to attract them permanently off the freeway and onto public transit.

When the price of gasoline is expected to increase 90% and, at the same time, the "threshold price" of by-choice transit riders will be exceeded, then the data in this study indicates that transit management might expect an increase in ridership of approx 23%.

It is recommended that the preliminary findings identified herein be the subject of more detailed studies of transit ridership with respect to routes, time of day, bus miles of operation, population density, and socio-economic characteristics. It is further recommended that the limitations implicit in this type of study be recognized.

Appendix.—References

1. Becker, B. W., Brown, D. J., and Schary, P. B., "Behavior of Car Owners During the Gasoline Shortage," *Traffic Quarterly*, Vol. 30, No. 3, July, 1976, pp. 469–483.
2. *CPI (Consumer Price Index) Detailed Report*, U.S. City Average and Selected Areas, U.S. Department of Labor, Bureau of Labor Statistics, Oct., 1971–Aug., 1980.
3. Cooper, Lawrence, "The Impact of the 1973–1974 Oil Embargo on Transit Line Ridership: The Case of Fort Worth, Texas," *Technical Report Series 2*, North Central Texas Council of Governments, Sept., 1977.
4. Corsi, T. M., and Harvey, M. E., "Travel Behavior Under Increases in Gasoline Prices," *Traffic Quarterly*, Vol. 31, No. 4, Oct., 1977, pp. 605–624.
5. Kain, J. F., "Energy Crisis and Proposed Solutions: Higher Gas Prices and the Role of Transit," Department of City and Regional Planning, Harvard University, presented to the U.S. House of Representatives, Committee of Ways and Means, Mar., 1975.
6. Kim, T. J., and Volk, W. L., "Creating an Upward Cycle in Urban Transit Ridership: A Case Study," *Traffic Quarterly*, Vol. 33, No. 4, Oct., 1979, pp. 501–510.
7. "Industry Statistics," *Metropolitan*, Vol. 76, No. 5, Sept./Oct., 1980, p. 118.
8. "Crisis Times and the Lines of '79," *Nation's Business*, Vol. 67, Aug., 1979, pp. 29–30.
9. "Industry Statistics," *Oil and Gas Journal*, Oct., 1971–Sept., 1980.
10. Ronan, W. J., "Financing Public Transportation," *Traffic Quarterly*, Vol. 29, No. 2, Apr., 1975, pp. 203–209.
11. Sacco, J. F., "Impact of the Energy Shortage on Travel Patterns and Attitudes," *Transportation Research Record 561*, 1976, pp. 1–11.
12. Sanson, R. L., "Energy, Land Use, and the Environment: The Impact on Transit," *Transit Journal*, Vol. 1, No. 4, Nov., 1975, pp. 6–20.
13. *Statistical Abstract of the United States, 1979*, U.S. Department of Commerce, Bu-

reau of the Census, Superintendant of Documents, U.S. Government Printing Office, Washington, D.C., 1979.
14. Stevenson, A. L., "Public Transit Ridership in Fort Worth: A Survey of Bus Ridership," thesis, presented to the University of Texas, Arlington, Texas, in Dec., 1978, in partial fulfillment of the degree of Master of Arts.
15. "How Cities Are Coaxing People Out of their Cars," *U.S. News and World Report*, Vol. 87, No. 26, Dec. 24, 1979, pp. 38–40.
16. *Weekly Petroleum Status Report*, Energy Information Administration, U.S. Department of Energy, Oct. 24, 1980.
17. Willey, W. E., "Transportation Planning and the Energy Crisis," *Traffic Quarterly*, Vol. 29, No. 2, Apr., 1975, pp. 273–283.