Technical Report Series

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The Impact of the 1973-74 Oil Embargo on Transit Line Ridership: The Case of Fort Worth, Texas

North Central Texas Council of Governments

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Abstract

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ABSTRACT:	Prepared in partial fulfillment of requirements for the degree of master of arts in Urban Affairs at the University of Texas at Arlington, May, 1977.

This paper examines the impact of the 1973-1974 Arab oil embargo on bus ridership in Fort Worth, Texas. An analysis of ridership changes experienced along individual bus routes identifies ridership and service variables which appear to be most influential in determining these changes. Finally, ways are suggested by which the study findings could be used by transit planners in developing contingency plans for possible future transportation fuel shortages.

Acknowledgements

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CHAPTER I

INTRODUCTION

STUDY PURPOSE

While much has been written and said about the "energy crisis" of 1973-1974, little effort has been placed on developing local strategies to deal with similar shortages in the future. The lessons learned from the past oil embargo seem to be forgotten by much of the American public as they continue to wastefully use energy, even while the nation's supply of this resource remains perilously insecure due to increasing reliance on imported sources.

Yet, there appears to exist a considerable information gap, especially at the local level, concerning the impact of this past fuel shortage. While most service station attendants could probably attest to longer lines of customers during this period and bus drivers could note the increase of persons riding their buses, the causes and effects of such phenomena often remain obscured by vague generalities. Reliable quantitative data on these occurrences have been gathered in few locations.

The purpose of this study, therefore, is to provide some much needed analysis on the former "crisis" which may be applied to future planning efforts. Since the impact of the fuel shortage on transportation appears to be one of the most dramatic, and perhaps the least understood, this paper will examine the effects of the crisis on one city's transit system, that of Fort Worth, Texas. It is further anticipated that the findings of this study may be directly incorporated in local and regional transit planning efforts of the North Central Texas area. And finally, while the conclusions and implications may be applicable only to this case study, it is hoped that the information will raise additional questions in other related subject areas as well as a renewed interest in the impact of the oil embargo on other transit systems.

BACKGROUND

Since the end of World War II, the United States has generally followed a policy which encouraged cheap and plentiful energy supplies. Within this time, total energy consumption in the nation has more than doubled and has outpaced domestic energy production every year since 1958.[1] Domestic oil production has fared even worse. American petroleum consumption has exceeded production every year since World War II and has resulted in reliance on increasing amounts of imported oil to meet these deficits[2] (Figure I-1). At the same time, the encouragement of resource conservation has been noticeably absent from national energy policy.

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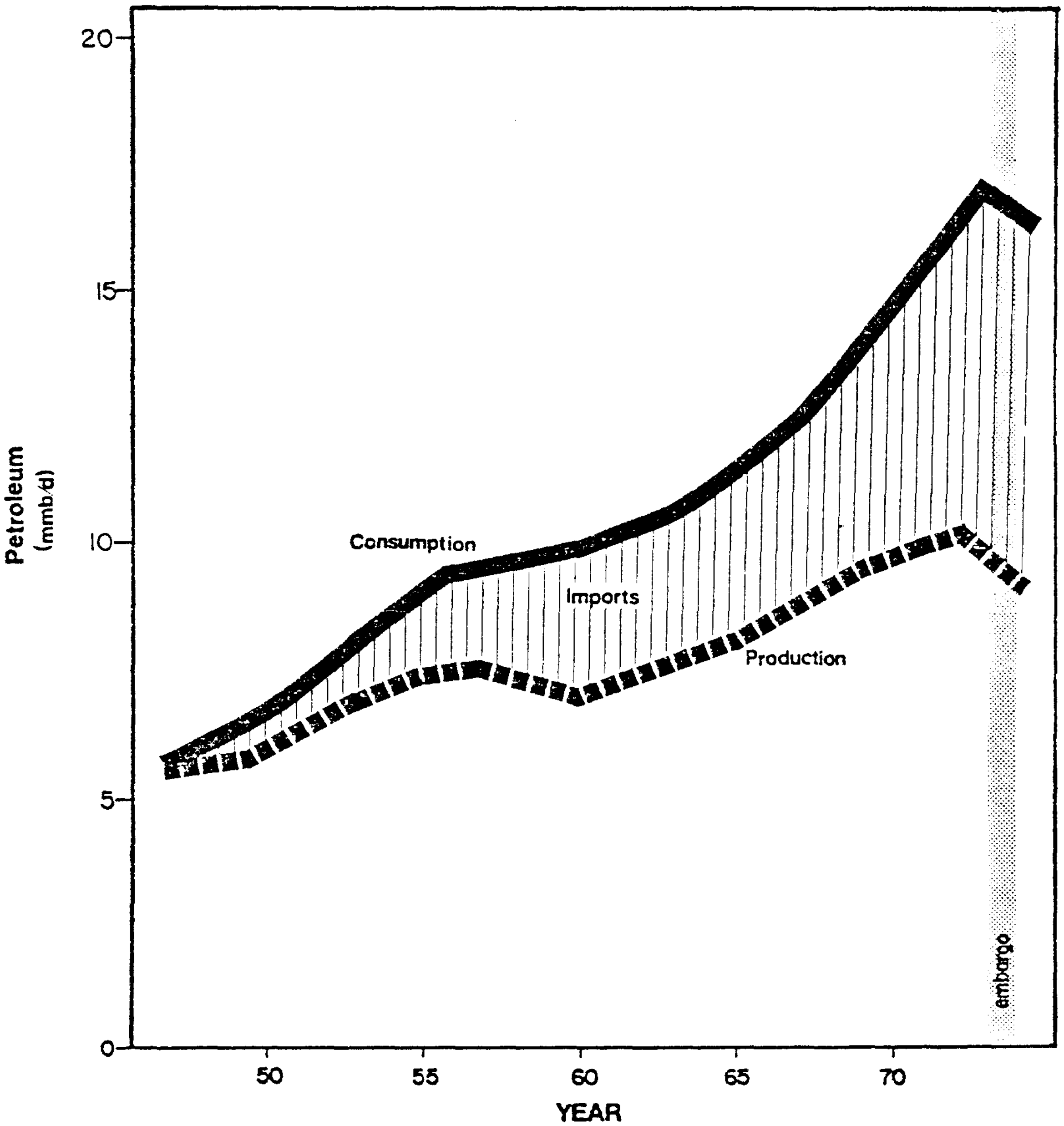
[1] Science Policy Research Division, Congressional Research Service, Library of Congress, Energy Facts (Washington, D.C.: U.S. Government Printing Office, November 1973), pp. 16, 43.

[2] The Ford Foundation, Energy Policy Project, Exploring Energy Choices (Washington, D.C.: The Ford Foundation, 1974), p. 2.

FIGURE I-1

U.S. PETROLEUM PRODUCTION VERSUS
CONSUMPTION, 1947-1974



Source: Federal Energy Administration, National Energy Outlook (Washington, D.C.: U.S. Government Printing Office, February 1976), p. xxiii.

A major reason for the increase in petroleum consumption has been the spectacular growth of motor vehicle utilization since World War II. The number of registered motor vehicles in the country increased from 30 million in 1945 to over 120 million by 1973.[3] The total vehicle miles traveled and amount of fuel consumed by these vehicles have also risen sharply (Figure I-2). Private passenger cars alone now number over 100 million and continue to increase at a rate greater than the general population (from 1970 to 1975, U.S. population has grown at a rate of about 1 percent yearly; during this period, automobile registrations have increased by over 4 percent annually).[4]

During this period of automobile proliferation, petroleum usage has been further burgeoned by a general decline in vehicle energy efficiency. An average American automobile in 1950 could travel over 15 miles on a gallon of gasoline.[5] By 1973, due to increased auto weight and the common use of fuel-consuming accessories such as air conditioning and power steering, the average fuel efficiency had dropped to 13.3 miles per gallon. Since the embargo, however, due to newly imposed federal

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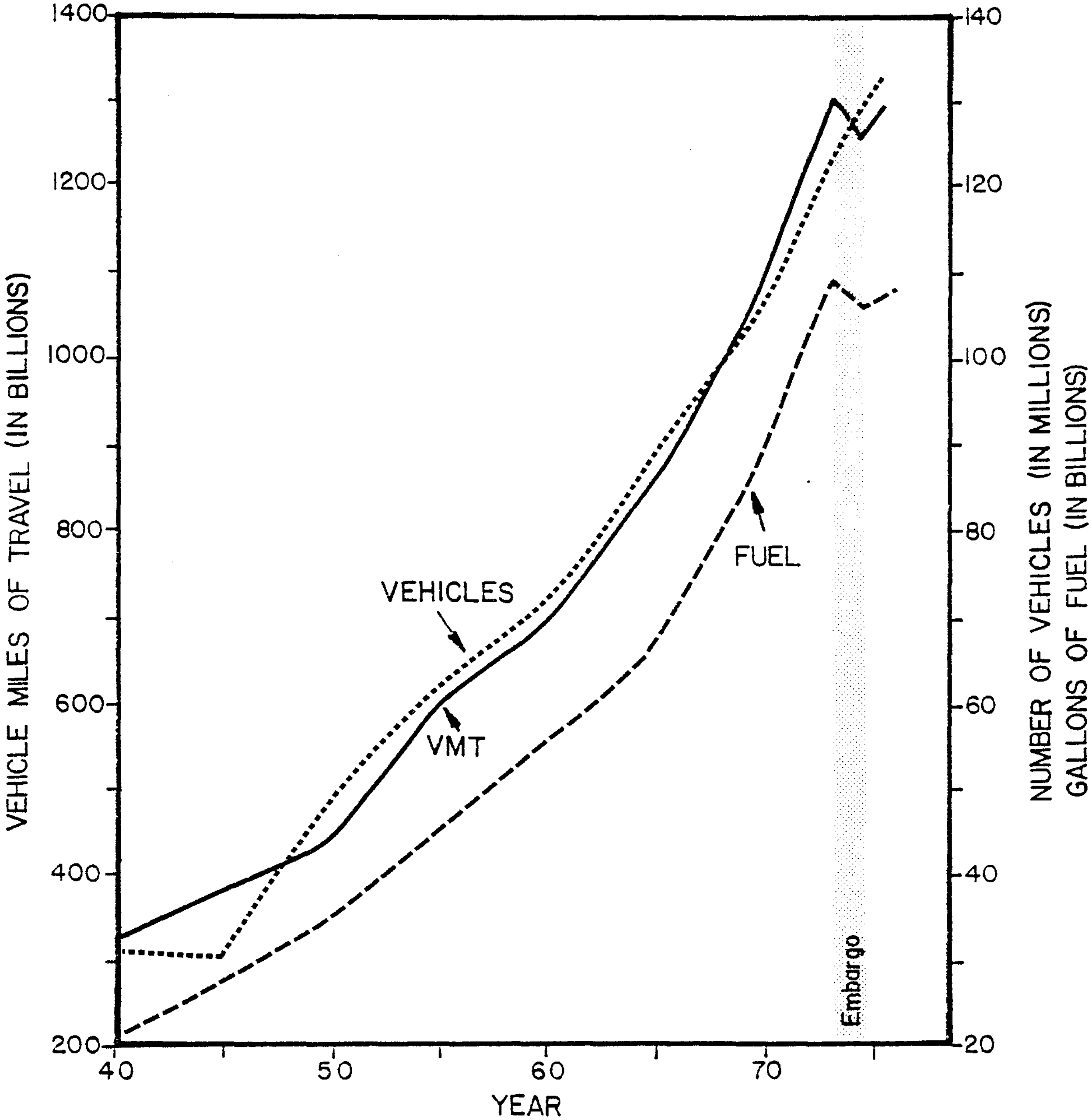
[3]Motor Vehicle Manufacturers Association, Motor Vehicle Facts & Figures '76 (Detroit, Michigan: Motor Vehicle Manufacturers Association, 1976), p. 29.

[4]Ibid.

[5]U.S. Department of Transportation, Energy Statistics (Washington D.C.: U.S. Government Printing Office, August 1975), p. 122.

FIGURE I-2

NATIONAL VEHICLE MILES OF TRAVEL, VEHICLES AND FUEL CONSUMPTION



Source: Motor Vehicle Manufacturers Association, Motor Vehicle Facts & Figures '76 (Detroit, Michigan: Motor Vehicle Manufacturers Association, 1976), p.70.

regulations governing automobile fuel efficiency, this figure has risen, reaching 13.5 miles per gallon in 1974 (Figure I-3).

A third major cause of the rapid increase in transportation-related petroleum consumption has been the rapid growth in the number of miles traveled by each automobile (Figure I-4). Due to the suburbanization of urban areas, the growth of the American highway system, as well as an increase in the amount of public leisure time for travel, the average automobile traveled nearly 1,000 miles more annually in 1972 than it did in 1950.

The end consequence of these trends has been a rapid acceleration in the consumption of petroleum for transportation (Figure I-5), especially by private automobile. In 1973, the transportation sector consumed 52 percent of all petroleum[6] and over half of this transportation use was by automobiles. Add to this the fact that automobile operation is nearly 100 percent dependent on petroleum products, and the importance of a reliable oil supply becomes a prime concern for continued auto usage and, thus, the current American lifestyle.

THE ENERGY CRISIS: SETTING THE STAGE

By the summer of 1973, automobile travel and gasoline consumption in the United States had reached all-time high levels. At the same time, the American transit

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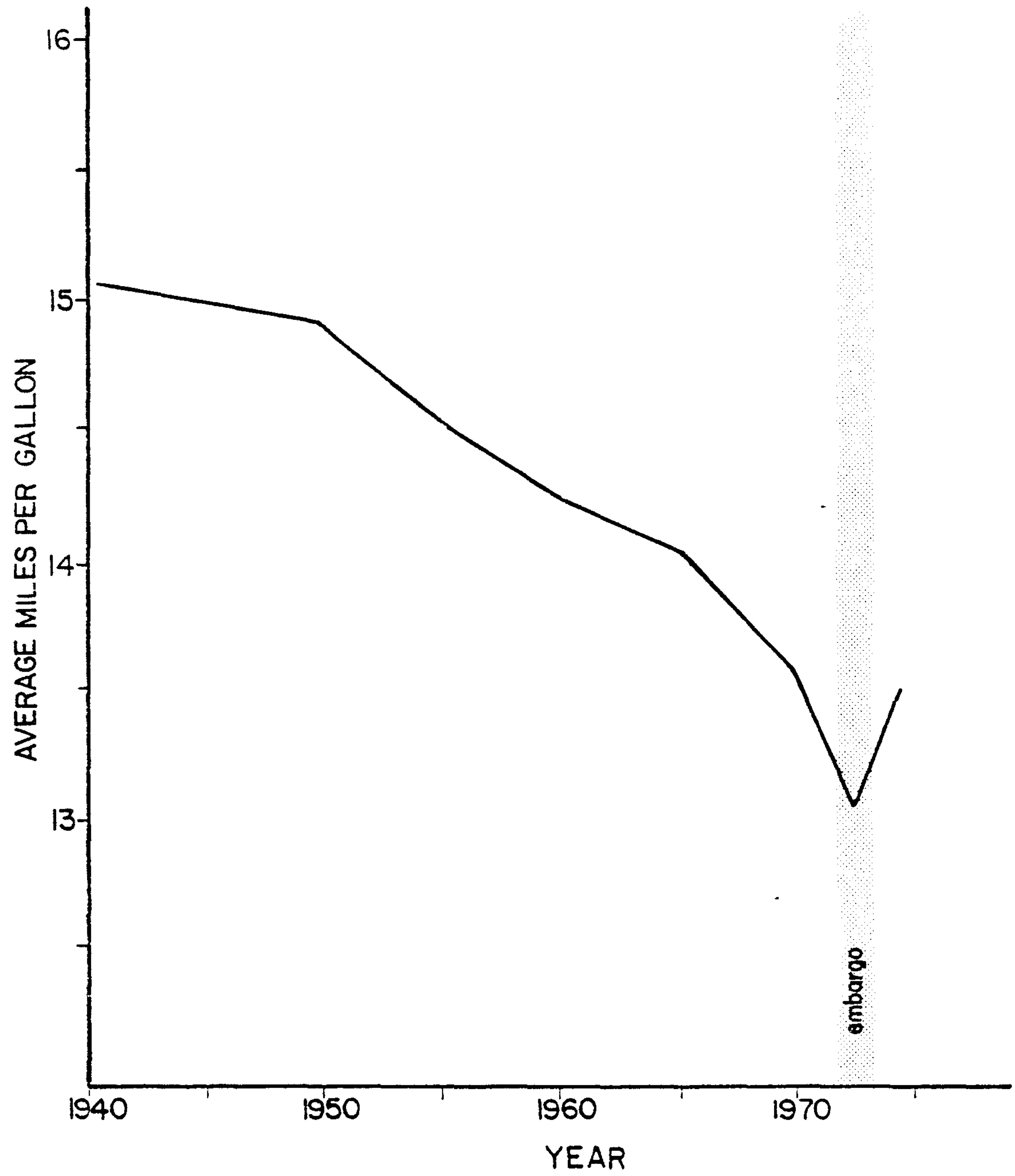
[6] U.S. Department of Transportation, Energy Statistics, p. 106.

FIGURE I-3

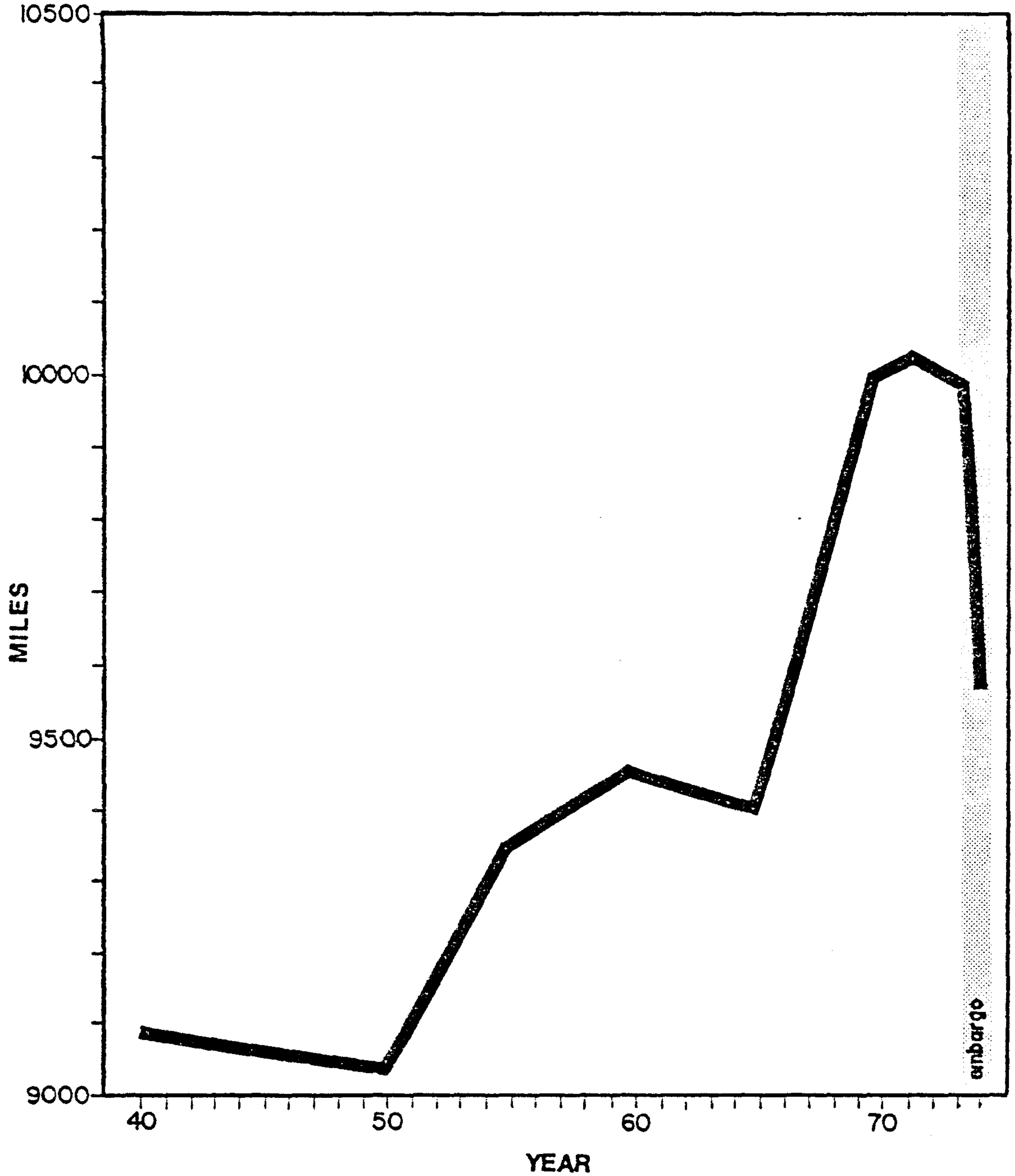
AVERAGE FUEL EFFICIENCY OF U.S. PASSENGER CAR FLEET, 1953-1974



Source: Motor Vehicle Manufacturers Association, Motor Vehicle Facts & Figures '76 (Detroit, Michigan: Motor Vehicle Manufacturers Association, 1976), p. 70.

FIGURE I-4

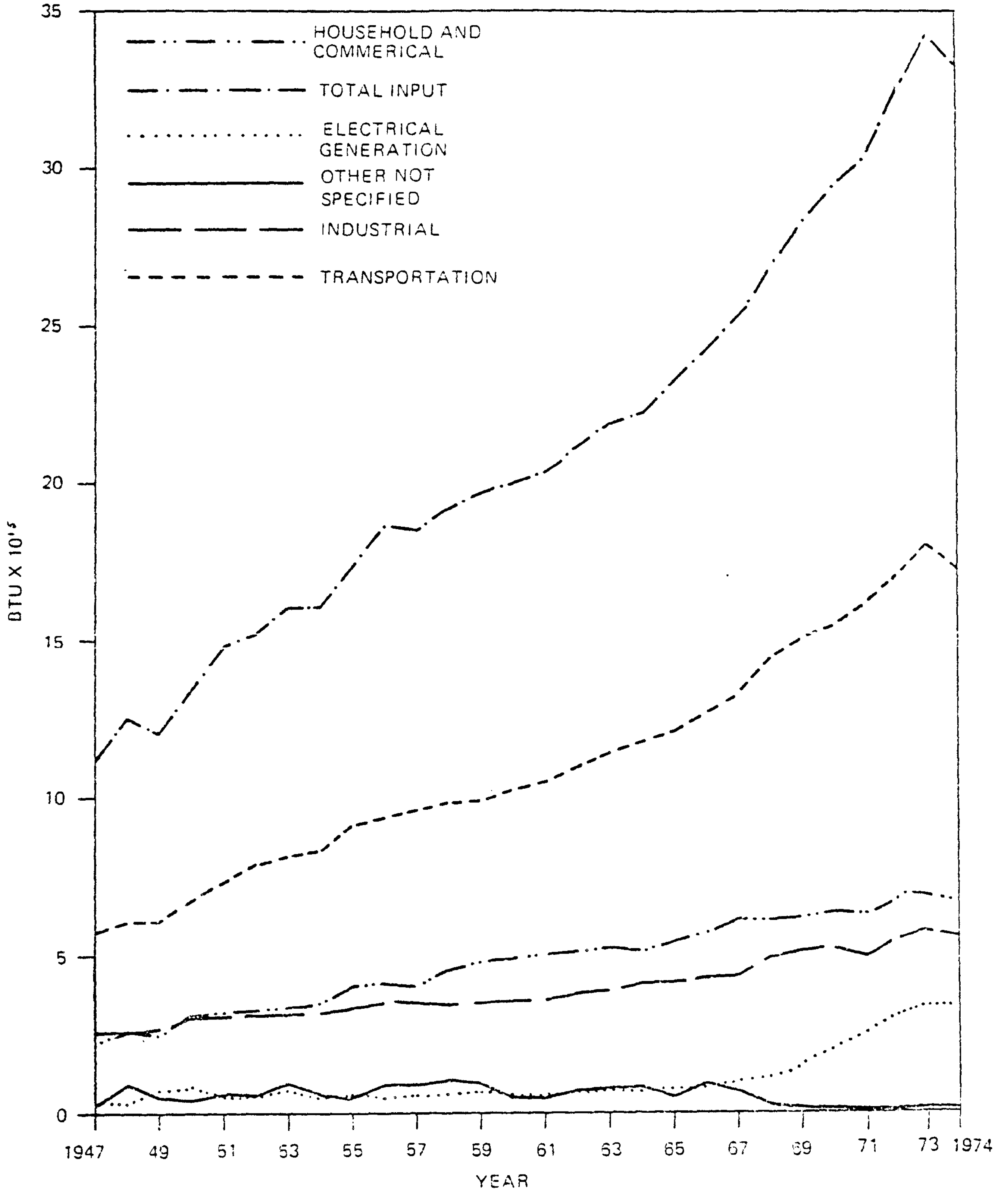
AVERAGE ANNUAL MILES TRAVELED PER VEHICLE
1940 to 1974



Source: Motor Vehicle Manufacturers Association, Motor Vehicle Facts & Figures '76 (Detroit, Michigan: Motor Vehicle Manufacturers Association, 1976), p. 70.

FIGURE I-5

PETROLEUM CONSUMPTION BY SECTOR, 1947-1974



Source: U.S. Department of Transportation, Energy Statistics (Washington, D.C.: U.S. Government Printing Office, August 1975), p. 107.

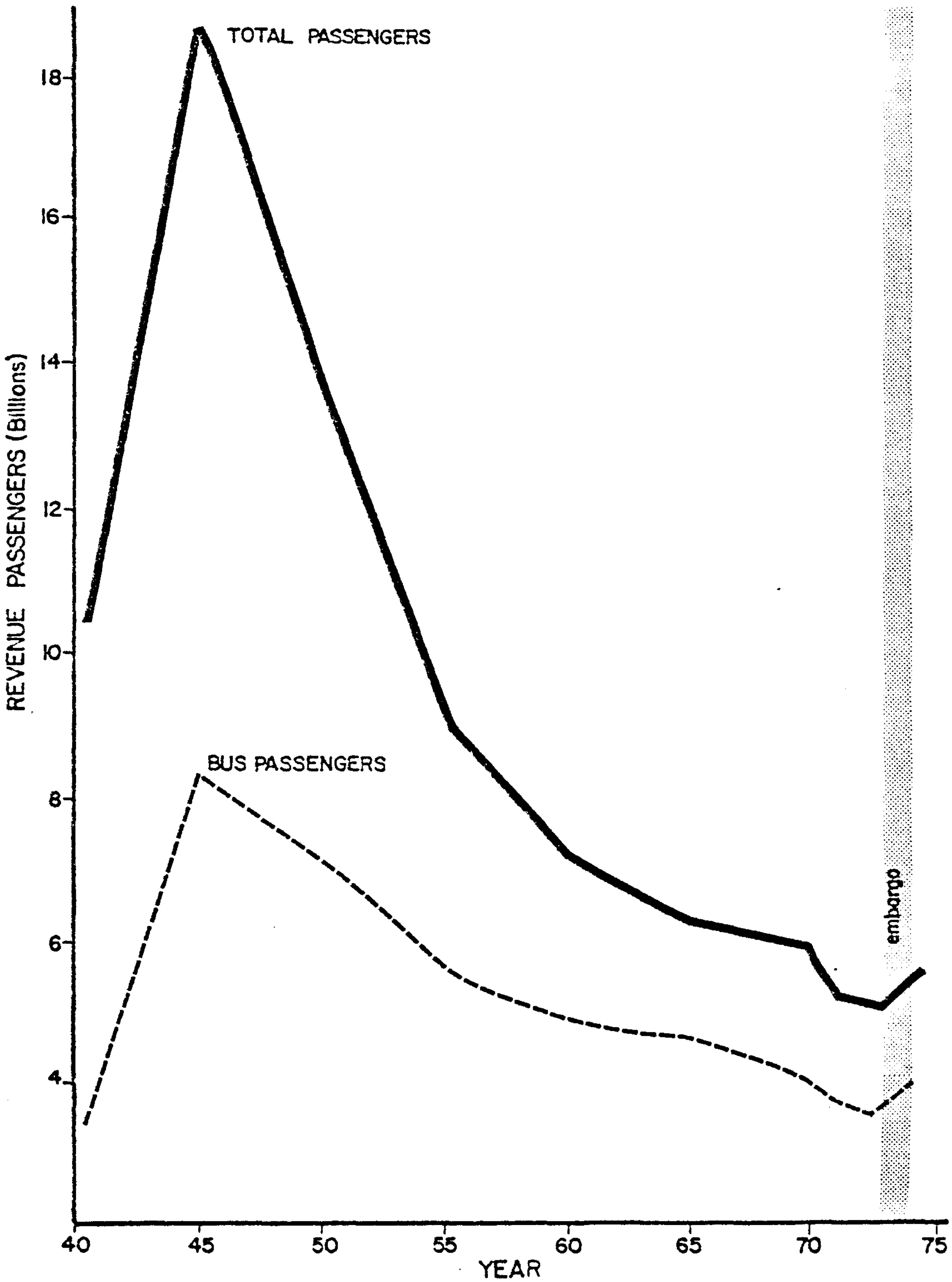
industry continued its downward trend to record low levels of ridership (Figure I-6). The international events of the autumn, 1973, however, soon reversed this pattern. Faced with the prospects of another military defeat at the hands of Israel during the Yom Kippur War, the Arab oil-producing nations, on October 21, 1973, as a political weapon, imposed an immediate ban on all petroleum exports to the United States and other "unfriendly" nations.

At this time, the U.S. relied on Arab oil imports for over 13 percent of its petroleum supply. The prospects of an oil shortage of this magnitude at a time when energy consumption was increasing at record rates threatened the growth of the national economy which was already experiencing a recession. Federal and local governmental agencies reacted by calling for immediate voluntary conservation measures and by developing energy-related policies to aid public and private conservation actions. President Nixon, in a series of national addresses on the energy problem, stressed the need to conserve energy, especially through such transportation-related measures as reducing maximum highway speeds, driving less, participating in carpools, and closing gasoline stations on Sundays. Throughout the nation, as individual communities initiated their own conservation programs, transportation became a prime target for energy-reducing actions.

The effect of these measures on transportation was instrumental in modifying the travel habits of a majority of Americans. While the automobile continued as the most

FIGURE I-6

TRANSIT REVENUE PASSENGER TRENDS, 1947 to 1974



Source: American Public Transit Association, Transit Fact Book, 1975-1976 Edition (Washington, D.C.: U.S. Government Printing Office, February 1976), p. 33.

important travel mode, its use was significantly reduced throughout all areas of the nation. Rising fuel pump prices, frequent difficulty in purchasing gasoline, and the resulting long lines at service stations which remained open succeeded in persuading Americans to drive only when necessary, if for no other reason than to avoid these long lines.

A national poll taken periodically during the embargo period by the National Opinion Research Center indicated that approximately 78 percent of the respondents tried to conserve gasoline during the crisis.[7] This was attempted mainly by driving less (66.5 percent) and driving slower (52.1 percent). Other measures used to conserve gasoline were tuning vehicle engines and using automobiles which produced better fuel mileage (Table I-1). Those who admitted to driving less did so mostly by taking fewer trips (54.6 percent). Others joined carpools, walked, and bicycled more. Only a small percentage (2.5 percent) said that they used more public transportation during this period (Table I-2).

THE IMPACT ON NATIONAL TRANSIT

The overall effect of the energy shortage on U.S. transit was substantial, but not as great as might have been anticipated. During the crisis period, on a monthly basis

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[7] James R. Murray et al., The Impact of the 1973-1974 Oil Embargo on the American Household (Chicago, Illinois: National Opinion Research Center, University of Chicago, December 1974), pp. 84-87.

TABLE I-1

PERCENT USING VARIOUS METHODS TO CUT DOWN ON USE OF GASOLINE

Method	Percent (N=2245)
Tried to cut down on gas last month	77.9
Cut amount of driving	66.5
Drove slower	52.1
Tuned-up car	24.2
Bought/used car with better mileage	12.9

Source: James Murray et al., The Impact of the 1973-1974 Oil Embargo on the American Household (Chicago, Illinois: National Opinion Research Center, University of Chicago, December 1974), p. 84.

TABLE I-2

PERCENT USING VARIOUS METHODS TO CUT DOWN ON AMOUNT OF DRIVING

Method	Percent (N=2245)
Went out less	54.6
Walked more	12.2
Joined carpool	8.1
Bicycled more	4.7
Used public transportation more	2.5

Source: James Murray et al., The Impact of the 1973-1974 Oil Embargo on the American Household (Chicago, Illinois: National Opinion Research Center, University of Chicago, December 1974), p. 86.

total transit ridership increased a maximum of 10.5 percent over similar periods the previous year.[8] These increases more importantly represent a reverse in the historical trend of transit ridership decline since World War II (Figure 6) and are, therefore, quite significant in this perspective.

While only 2.5 percent of the respondents in the NORC poll said that they used public transit more during the energy crisis, these increases were quite important to transit operators. This same survey indicated a 1 percent rise in the number of persons whose usual mode of transportation to work was by public transportation. When, however, it is recognized that this slight increase represents an additional one million transit riders each workday, the impact on national transit operations could be substantial.

Furthermore, these national averages do not depict the often dramatic impact of the crisis on transit patronage in individual urban areas. In the Dutch Fork area of Columbia, South Carolina, for instance, bus ridership increased by nearly 300 percent during the peak of the crisis, coincidental with the longest lines at service stations.[9] Similar gains were experienced by other transit systems, especially those in medium-sized cities whose transit patronage had previously remained at relatively low levels.

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[8] United States Congress, Office of Technology Assessment, Energy, the Economy and Mass Transit (Washington, D.C.: U.S. Government Printing Office, December 1975), p. 59.

[9] Ibid., p. 67.

Certain interurban transit routes were also greatly affected. Ridership on an intercity commuter bus route between Irving and Dallas, Texas increased by as much as five times the normal usage.[10] Ridership, however, soon fell to pre-crisis levels once the embargo was ended.

Thus, the energy crisis succeeded in stimulating a new, though generally temporary, interest in American transit and its role in urban development, a feat which transportation planners and transit operators have had little success in accomplishing previously. And, as transit systems throughout the nation were overwhelmed by new riders, they became painfully aware that, with few exceptions, past planning has shown little sensitivity to the energy problem.

TRANSIT AND ENERGY: THE FUTURE

While most scholars generally agree that mass transit will play an important role in the future of urban transportation, few have attempted to quantify their forecasts. This obvious caution in defining transit's future role undoubtedly lies in the uncertainty of the American energy situation and its potential effect on transportation. One exception,

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[10] North Central Texas Council of Governments, memo by Pat Hitchcock regarding conversations with area busline managers on energy contingency plans, unpublished (Arlington, Texas: Transportation Department, April 3, 1975).

a study by the United States Office of Technology Assessment,[11] has attempted to formulate transit ridership forecasts based on three possible energy scenarios: a mild decrease in energy supply, a moderate decrease, and a severe decrease. This was estimated by using the equation:

$$TRP = 1.063\ (TVMT)^{-.866}$$

where

TRP = the annual growth factor for transit revenue passengers

TVMT = the annual growth factor for highway vehicle miles of travel, and 1.063 represents a constant based on the assumption of a 10 percent rate of inflation, a 9 percent decrease in transit fare, and a transit elasticity of 3.

The study predicts that a severe decrease in energy assumption by 1980 would increase ridership by over 40 percent (Table I-3). Moreover, since these forecasts are greatly reliant on how the consumer perceives the shortage (which, therefore, accounts for the limited consumer reactions to the 1973-1974 embargo which was generally judged to be temporary), the public may seek to make more substantial modifications to their travel patterns during a long-term shortage. In such a case, these predicted transit increases may actually be underestimated.[12]

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[11] United States Congress, Office of Technology Assessment, <u>Energy, the Economy and Mass Transit</u>, p. 68.

[12] Ibid.

TABLE I-3

EFFECT OF ENERGY FUTURES ON TRANSIT REVENUE PASSENGERS
MILLION OF ANNUAL REVENUE PASSENGERS
(PERCENT CHANGE FROM 1974)

	Mild Decrease	Moderate Decrease	Severe Decrease
1977	6118 (+8.8)	6798 (+20.9)	6961 (+23.8)
1978	6039 (+7.4)	6809 (+21.1)	7316 (+30.1)
1979	5960 (+6.0)	6826 (+21.4)	7642 (+35.9)
1980	5882 (+4.6)	6838 (+21.6)	7878 (+40.1)

Source: United States Congress, Office of Technology Assessment, Energy, the Economy and Mass Transit (Washington, D.C.: U.S. Government Printing Office, December 1972), p. 59.

To sum, the availability of energy has and will continue to play a significant role in transit ridership. The ability of transit operators to cope with this changing scene will rely to a large extent on the success of these systems in assessing their individual capabilities and in preparing adequately for possible short-term impacts.

THE FUTURE SCENARIO: A NEED FOR PLANNING

While much has been written about the impact of the energy shortage on urban areas, little detailed analysis has been accomplished concerning its effects on localized transit usage. Most transit operations recognize the systemwide changes in ridership, but few have attempted to examine the line-by-line variations, and fewer still have examined and related the 1973-1974 changes with regard to future contingency plans.

Meanwhile, the chance of another oil embargo on the United States has not diminished. This country's dependence on imported oil has actually grown since the last embargo (over 50 percent was imported in recent months, compared to 33 percent in 1973)[13] and policital instability in many of these supplying nations remains a constant threat to continued shipments. If an embargo situation were to develop in the near future, the presence of a 20 percent oil shortfall (about what OPEC nations would be supplying at this time) would almost certainly lead to a national policy of consumer fuel rationing or severely restricted service station allocations.

The resultant impact of this scenario on the existing transportation system would most certainly be dramatic. Automobile use would be curtailed whenever the consumer finds it expedient to do so. At the same time, transit ridership would probably rise dramatically, while limited transit facilities and imposed energy restraints could make satisfying these demands a difficult task. Transit planners and operators must be able to react quickly with appropriate measures if their operations are to function efficiently. Areas of the city with increased transit demands must be identified and evaluated for additional

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[13] Federal Energy Administration, "The Energy Crisis: How Did It Happen?", Energy Reporter, December 1976/January 1977, p. 2; Federal Energy Administration, Federal Energy News, March 26, 1976, p. 1.

service. The transit planners should also be able to prioritize service which could be curtailed if fuel shortages made this strategy necessary.

However, while it would be desirable to prepare for such an emergency, few planning efforts have considered this possibility. Energy sensitivity in transportation planning remains a relatively new and often unknown variable. Models currently used to predict ridership under normal conditions are inappropriate to predict additional ridership under energy constraints. Indeed, little is known about what kinds of persons would be most likely to abandon their automobiles to use transit. A recent assessment of energy analysis in urban transportation systems concludes that this inability to address energy issues

> ...may have been anticipated to some extent, since transportation planning techniques evolved during the 1950's and 1960's, when the possibility of fuel shortages or price increases that would influence travel demand, and subsequently the need for transportation investments, was to most professionals remote at best. Only a handful of long-range transportation plans prepared in the 1960's gave more than lip service to the possibility of energy constraints in the future. And analysis of travel forecasting and evaluation techniques shows generally a paucity of procedures that are sensitive in any real sense to energy policies, particularly reduced fuel availability. The logical conclusions, then, is that, generally speaking, transportation planning and the projections made therefrom are not energy sensitive.[14]

An initial step in resolving this problem would be to analyze the effects of the 1973-1974 oil embargo on transit. It is, therefore, the purpose of this study to investigate this impact on transit ridership in one American city, Fort Worth, Texas.

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[14] David Hartgen, "Energy Analysis for Urban Transportation Systems: A Preliminary Assessment," Transportation Research Record 599, 1976, p. 31.

STUDY APPROACH

Primary Hypothesis

This study was conducted on two levels of analysis. The question examined was the impact of the 1973-1974 oil embargo on transit line ridership. The primary hypothesis examined the propositions that energy constraints, such as those imposed during the embargo period, produced no significant difference in ridership load changes between transit lines. This was tested by analyzing line ridership data from the Fort Worth transit system (CITRAN) for the embargo period.

Secondary Hypothesis

The null hypothesis was invalidated. Next, this study hypothesized that certain variables, such as the quality of the transit service or demographic characteristics of the transit service area, were determinants of the ridership changes noted. A factor analysis of these transit ridership variables was then conducted to determine the degree of correlation between these factors and the ridership changes.

Methodology

In order to ascertain the effect of the 1973-1974 energy crisis on transit ridership in Fort Worth, monthly line ridership data (revenue passengers) for the embargo period months (October, 1973, to March, 1974) as well as for each month prior to and after the crisis were obtained from CITRAN. These data were then compared to ridership totals during corresponding months of the previous year and a percent ridership change was calculated for each line during each month. Since the percentage ridership change varied greatly from month to month, it was necessary to assign each line a single representative percentage change for analysis purposes. It was decided that the figure which represents the maximum change each line experienced would be more applicable to planning purposes than an average change because the transit system would have to plan for this highest level. This figure was obtained by calculating the mean of the two embargo period months with the highest increases in ridership (or lowest decreases, as the case may be). An example of this procedure is outlined below:

Bus Line: El Campo

Target Month	Percent Ridership Change from Similar Month the Previous Year
September, 1973	+ 0.28
October, 1973	- 1.74
November, 1973	+ 4.43
December, 1973	+ 4.79
January, 1974	+14.77
February, 1974	+15.23
March, 1974	+16.25
April, 1974	+17.61
Assigned Change (Mean of two highest months)	+16.93

The next procedure was to analyze the characteristics of each line in order to identify transit-related variables which may have influenced the ridership change. Three major types of variables were analyzed: transit service (bus speed, headway), preembargo bus rider characteristics, and bus service area neighborhood characteristics (from which new ridership would be drawn). While it would have been very desirable to obtain ridership data on passenger characteristics during the embargo period to compare with normal ridership, such information unfortunately did not exist. A major goal of this study, therefore, was to identify the type(s) of new transit patrons who were largely responsible for ridership increases in their occurring areas. This was accomplished through a close examination of all of the affected lines and a correlation analysis of variables important to ridership choice. In addition, supportive data from local (Urban Panel, NCTCOG) and national surveys on public reactions to the 1973-1974 energy crisis were utilized to reinforce the conclusions.

The final step was then to define the characteristics of transit lines which have experienced energy-imposed increases and suggest the applicability of these inferences to related planning efforts. Further suggestions examine the implications of these findings and the need for future research.

The following chapter describes the case study area, Fort Worth, its bus system, and its reaction to the 1973-1974 energy crisis. Chapter III examines the bus ridership, bus corridor, and bus service characteristics which have been included in the factor analysis. Chapter IV quantifies the percentage change experienced by each of the bus lines during the embargo period. Chapter V describes the correlation analysis which was performed between the variables identified in Chapter III and the line changes noted in Chapter IV. Finally, Chapter VI provides an analysis of the findings and implications of the correlation analysis and Chapter VII assesses the applicability of these findings to transit planning.

CHAPTER II

THE CASE STUDY: FORT WORTH, TEXAS

The city of Fort Worth is situated next to the Trinity River on the broad, rolling Grand Prairie subregion of the North Central Plains (Figure II-1). Its approximately 400,000 residents enjoy a moderate climate characterized by mild winter temperatures (it rarely snows) and warm, dry summers. Its generally agreeable weather easily facilitates year-round outdoor activities and seldom interfaces with local travel patterns.

Fort Worth has enjoyed relative prosperity and modest growth since World War II. Its population has increased over 10 percent from 1960 to 1970,[15] but has since stabilized with the rapid development of surrounding suburban communities in Tarrant County. The downtown business district, which employs over 40,000 workers,[16] continues to expand and prosper as a commercial and financial center for the surrounding hinterland.

Socioeconomic indicators (Table II-1) suggest that Fort Worth lacks many of the extremes which plague other large cities. While poverty and low-income districts can be found,

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[15] U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population and Housing, Census Tracts, Fort Worth, Texas, Standard Metropolitan Statistical Area (Washington, D.C.: U.S. Government Printing Office, 1972).

[16] North Central Texas Council of Governments, estimates.

FIGURE II-1

THE LOCATION OF FORT WORTH, TEXAS

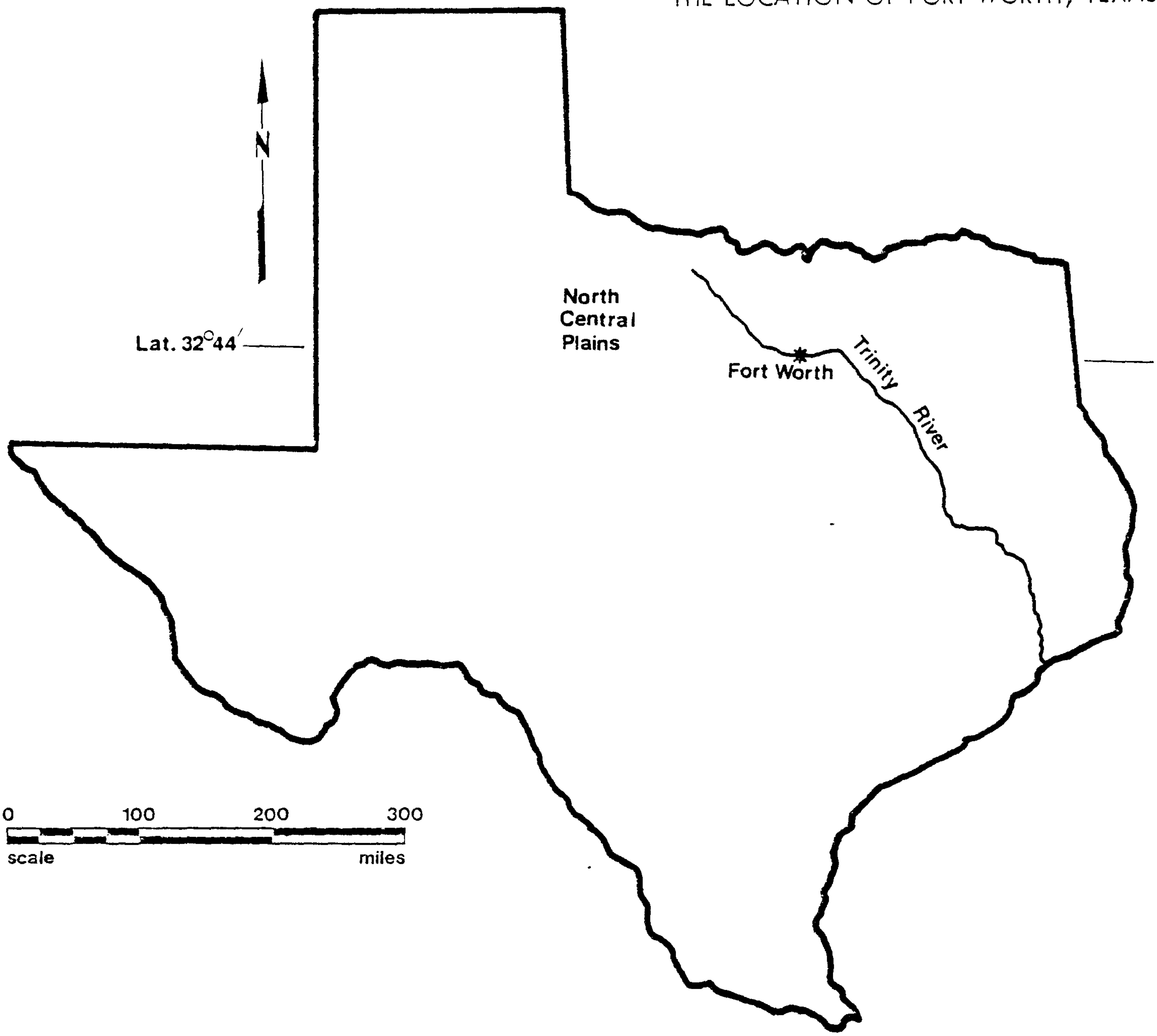


TABLE II-1

FORT WORTH SOCIOECONOMIC INDICATORS
(1970)

Population	393,455
Median family income	$ 9,271
Percent below poverty level	10.3
Percent Black population	19.9
Percent Spanish population	8.5
Percent households with no automobile	13.3

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population and Housing, Census Tracts, Fort Worth, Texas, Standard Metropolitan Statistical Area (Washington, D.C.: U.S. Government Printing Office, 1972).

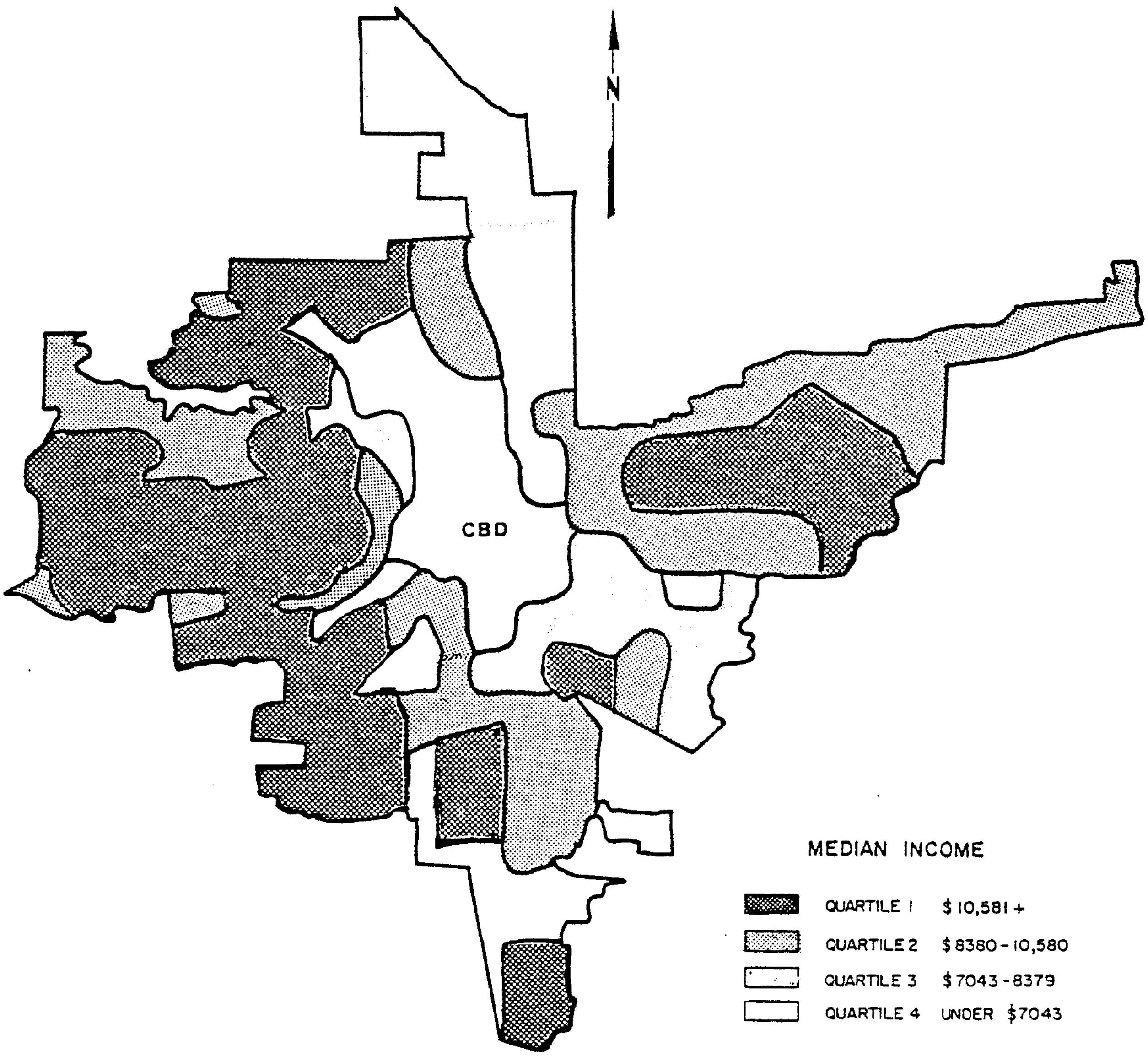
especially near the city center (Figure II-2), their adverse influence on the city development remains relatively mild.

REACTIONS TO THE ENERGY CRISIS

Initial public reaction to the 1973-1974 energy crisis in the Fort Worth area was not as profound as in similarly-sized cities in the eastern part of the nation. Below-average fuel pump prices and adequate regional petroleum stocks delayed the adverse effects of a fuel shortage at the outset of the embargo. By January, 1974, however, as local fuel allocation levels began to decrease, spot gasoline shortages began to appear at service stations.

FIGURE II-2

FORT WORTH FAMILY INCOME, 1970



Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population and Housing, Census Tracts, Fort Worth, Texas, Standard Metropolitan Statistical Area (Washington, D.C.: U.S. Government Printing Office, 1972), Table P-8.

A survey[17] by the Transportation Department of the North Central Texas Council of Governments indicated that 70 percent of the local retail gasoline outlets ran out of gasoline supplies at some time during the embargo (Table II-2). The majority of stations reacted to this problem by reducing operating hours, closing on Sundays, and limiting customer fuel sales. In addition, 77 percent of the outlets experienced longer than usual customer lines during this period.

Another noticeable impact of the embargo was the rapid increase in gasoline pump prices. The retail price of gasoline increased from an average of 35 cents a gallon in October, 1973, to over 41 cents by January, 1974 (Table II-3).[18] By the end of the embargo, the average price for a gallon of regular gasoline was about 50 cents.

The impact of these events and the simultaneous media campaign for public cooperation resulted in a new awareness of the need for energy conservation. Much of this new consciousness was directed towards the public's driving habits. A survey of residents in the Fort Worth area completed by the North Central Texas Council of Governments reported that 85 percent of the respondents from that city tried to use less gasoline during the energy crisis (Table II-4).[19] When asked how the energy crisis affected their driving

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[17] North Central Texas Council of Governments, "Service Station Survey" (Arlington, Texas: Transportation Department, June 1976).

[18] U.S. Bureau of Labor Statistics, "Consumer Prices" (Dallas, Texas: Region Six Bureau of Labor Statistics, July 23, 1976).

[19] North Central Texas Council of Governments, Urban Panel Project (Arlington, Texas: Transportation Department, September 1976).

TABLE II-2

DALLAS-TARRANT COUNTY SERVICE STATION POLL*

	Total n=92	Dallas County	Tarrant County	Major oil companies	Independents
Limited customer fuel sales	61%	60%	62%	66%	50%
Reduced hours of operation	72	70	75	83	46
Closed on Sundays	71	68	75	78	53
Longer than usual lines	77	80	72	86	63
Gas sales decreased	61	61	60	68	44
Ran out of gasoline	70	66	78	82	50
Curtailed complimentary customer service	29	35	14	22	61
Started self-service pumps	9	11	5	7	23

*Percent answering Yes

Source: North Central Texas Council of Governments, "Service Station Survey" (Arlington, Texas: Transportation Department, June 1976).

TABLE II-3

DALLAS-FORT WORTH GASOLINE PUMP PRICES

	Month	Regular Gasoline	Premium Gasoline
	October, 1973	$ .352	$ .389
	November	.365	.400
	December	.382	.420
Embargo Period	January, 1974	.417	.452
Embargo Period	February	.449	.484
Embargo Period	March	.487	.524
Embargo Period	April	.503	.537
Embargo Period	May	.507	.540
	June	.515	.547
	July	.511	.548
	August	.512	.550
	September	.507	.546
	October	.497	.536
	November	.484	.523
	December	.484	.524
	January, 1975	.484	.527

Source: U.S. Bureau of Labor Statistics, "Consumer Prices" (Dallas, Texas: Region Six Bureau of Labor Statistics, July 23, 1976).

TABLE II-4

FORT WORTH RESIDENTS AND ENERGY CRISIS GASOLINE USAGE

Response	Number	Percent
Used less gasoline	346	85
Uncertain	14	3
Did not use less gasoline	48	12
Total	408	100

Question: I tried to use less gasoline during the last energy crisis.

habits (Table II-5), the most common responses were to take fewer trips and drive their automobiles slower. In addition, 7 percent of all respondents admitted to using the bus more during this period.

Thus, while consumer reaction to the energy shortage did not appear to be exceptionally severe in the Fort Worth area, the lifestyles of many of the city residents appears to have been affected by its impact. Much of this public reaction manifested itself through a change in consumer travel habits which included increased utilization and awareness of public transit as an attractive transportation alternative.

TABLE II-5

ENERGY CRISIS EFFECTS IN DRIVING HABITS

Response	Number	Percent*
Carpooled	50	12
Used bus more	29	7
Bought smaller car	61	15
Took fewer trips	169	41
Drove slower	162	39
Nothing	78	19
Other	32	7

*Based on number of respondents (461) indicating that alternative. More than one response was allowed.

Question: How did the last energy crisis affect your driving habits?

Source: North Central Texas Council of Governments, Urban Panel Project (Arlington, Texas: Transportation Department, September 1976).

THE CITY BUS SYSTEM: CITRAN

The decline of transit patronage in Fort Worth, to a great degree, mirrored the national trends. As Table II-6 indicates, ridership on the city bus system has steadily declined since 1947.[20] These decreases and the accompanying reductions in the service provided resulted in financial problems for the privately operated Fort Worth Transit Company.

[20]Data supplied by CITRAN, published in the 1976 Transportation Program by the North Central Texas Council of Governments.

TABLE II-6

FORT WORTH HISTORICAL RIDERSHIP TREND

Year	Revenue Passengers Carried for Years Shown	Percentage Increase (Decrease)
1947	42,625,457	
1948	41,989,801	(1.5)
1949	37,420,629	(10.9)
1950	32,226,954	(13.9)
1951	30,208,512	(6.2)
1952	27,686,982	(8.4)
1953	24,632,675	(11.0)
1954	21,361,937	(13.3)
1955	18,811,662	(11.9)
1956	16,696,651	(11.2)
1957	15,871,704	(4.9)
1958	13,373,642	(15.7)
1959	12,950,886	(3.2)
1960	12,099,781	(6.6)
1961	10,751,162	(11.2)
1962	10,228,920	(4.9)
1963	8,887,598	(13.1)
1964	8,024,228	(9.7)
1965	7,455,965	(7.1)
1966	7,860,593	5.4
1967	7,738,573	(1.6)
1968	7,649,636	(1.2)
1969	6,846,147	(10.5)
1970	5,892,223	(13.9)
1971	5,107,847	(13.3)
1972	4,628,874	(9.4)
1973	4,498,324	(2.8)
1974	4,473,689	(0.5)

Source: Data supplied by CITRAN, published in the 1976 Transportation Program, North Central Texas Council of Governments, 1975.

These problems culminated in the purchase of the transit system by the City of Fort Worth and the formation of the City Transit Service of Fort Worth (CITRAN) in August, 1972.

A comprehensive study of the bus system[21] completed prior to the takeover suggested alternative improvement programs and actions. Based on this, the new transit company began a major rebuilding program to provide better bus service to city residents. By 1973, the CITRAN bus system had completed much of its major improvement goals, including the purchase of new buses, a better communications system, and routing and scheduling improvements. During this time, the system's 100 buses made service available to over 90 percent[22] of the city's residents along 28 routes through various socio-economic areas of the community (Figure II-3). Approximately 15,000 passengers were riding the bus system on an average weekday.[23] However, even with the service improvements, overall ridership continued to decline.

THE BUS LINES

Of the 28 bus routes which operated during the 1973-1974 embargo period, nearly half have been modified in some form since 1972 company reorganization. Since these

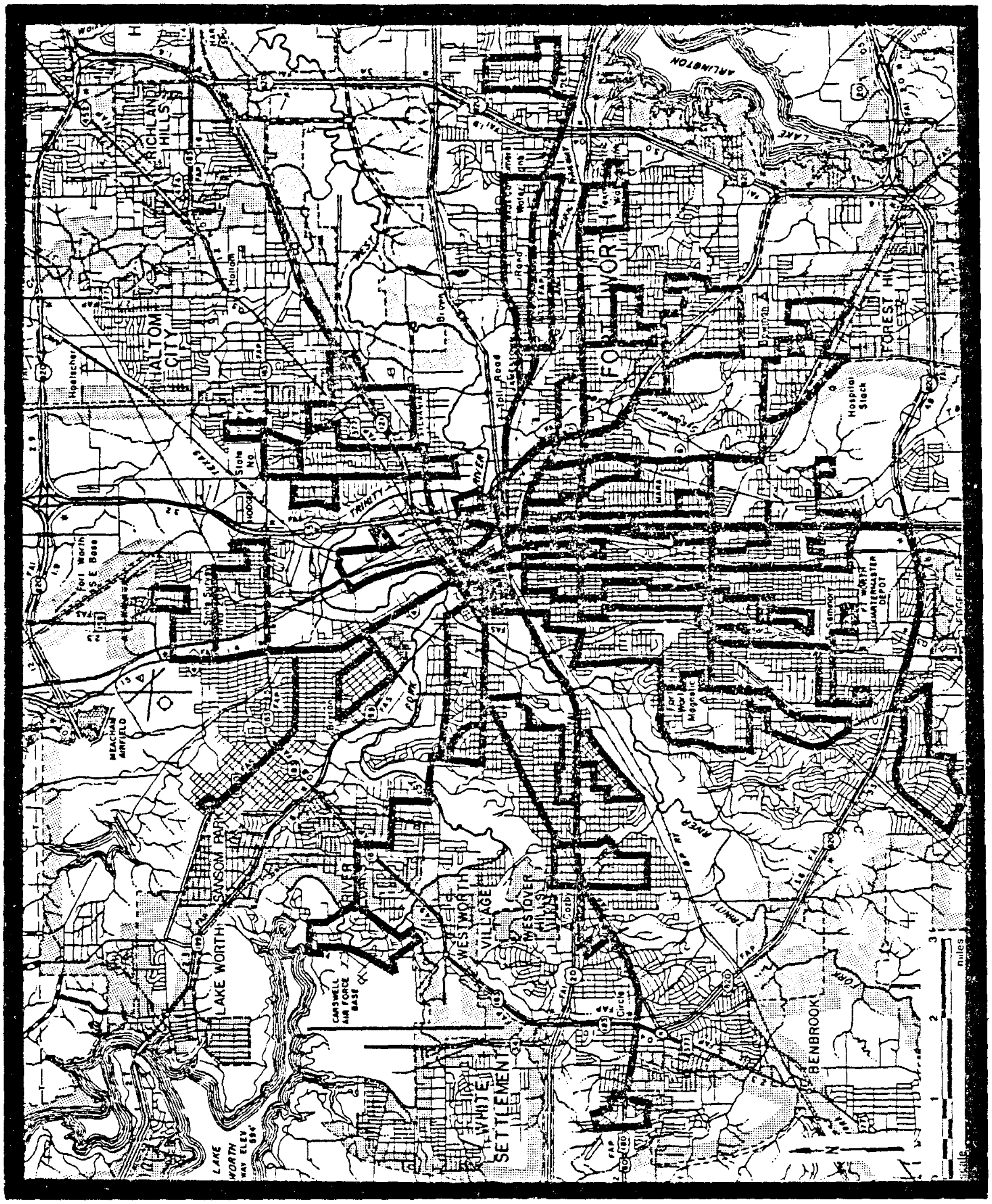
[21] Alan M. Voorhees & Associates, Inc., Fort Worth Bus Operational Study (Fort Worth, Texas: September 1971).

[22] North Central Texas Council of Governments estimates, based on $\frac{1}{4}$ mile service corridors.

[23] Estimates based on CITRAN data.

FIGURE II-3

CITRAN BUS ROUTES, 1973



Source: CITRAN Bus Map, Fort Worth, 1972-1974.

service and route changes would make a year-to-year comparison of these lines invalid, only those routes which experienced little or no modifications between the 1972-1974 period were analyzed. The following presents a brief description of the 15 lines to be examined in this study as they existed in late 1973.[24]

Angle-Jarvis

The Angle-Jarvis bus route serves the northern section of the city and was also known as the Airport Shuttle when it extended into Meacham Airfield. The route is divided into two major loops and the north-south Main Street extension to the CBD (Figure II-4). The Angle Loop serves a primarily low-density, lower-income residential area. The Jarvis Loop differs slightly in that the residential land is of medium-density with a middle-income population. The Main Street downtown connection runs through a largely industrial and commercial area.

Berry

The Berry Street Shuttle includes a loop around the Texas Christian University campus and an extension along Berry Street to Hemphill. The loop serves a middle- to high-income population in a low- to medium-density neighborhood. The extension runs through a strip commercial and low- to medium-density single family residential area in the middle-income range.

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[24] Line descriptions are based on the Fort Worth Bus Operational Study, Appendix 2, "Transit Design Criteria and Route Reconnaissance," September 1971.

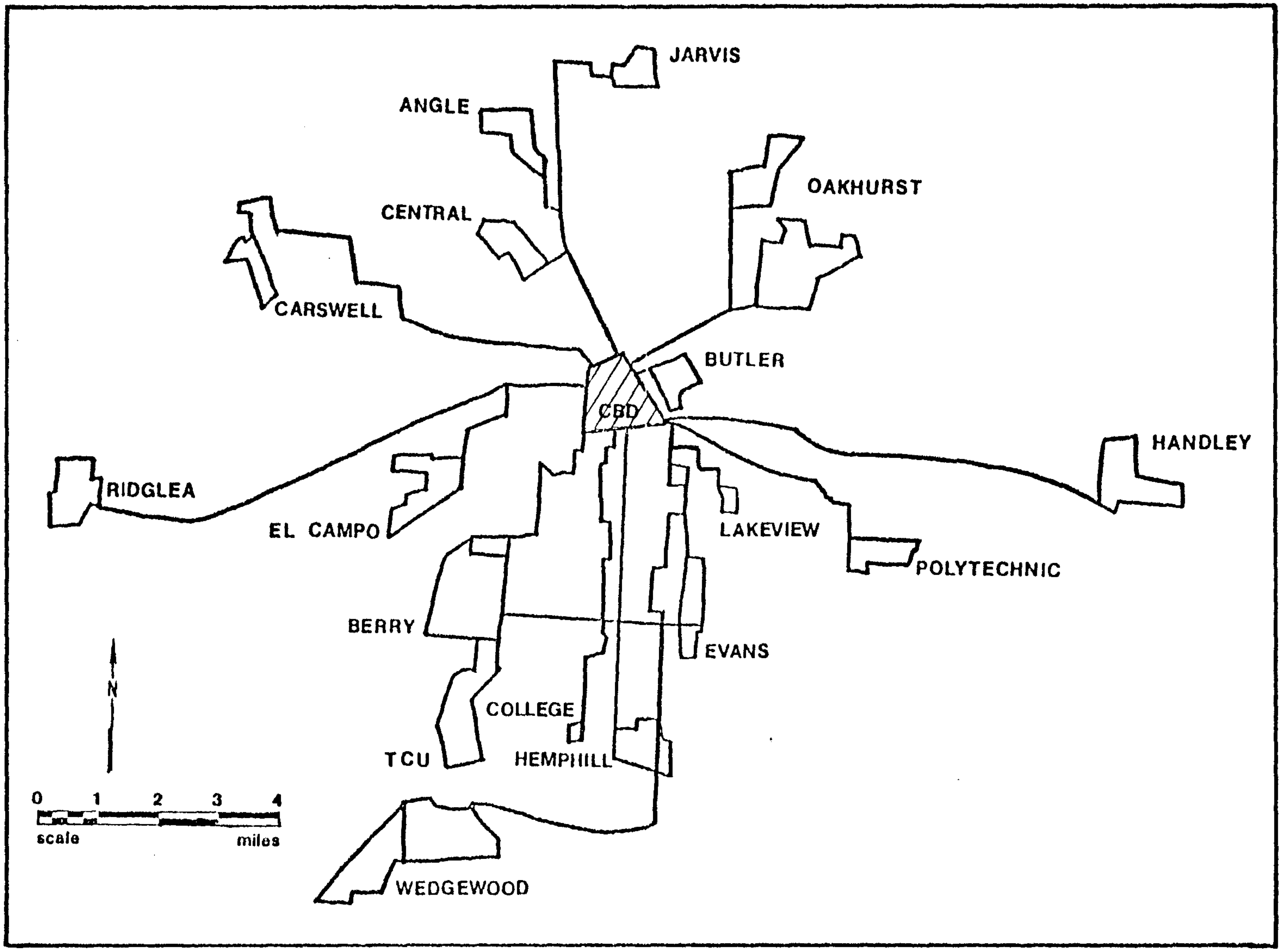

FIGURE II-4

CITRAN CASE STUDY BUS LINES, 1973

Carswell

The Carswell route includes a loop around the residential area to the east of Carswell Air Force Base and an extension along White Settlement Road to the CBD. The loop includes land use by the Air Force base, residential units, and spot commercial sites. The housing density is low to medium with a low- to low-medium income level. Land use along the CBD connection includes residential, strip commercial, and some CBD fringe activity. The housing density is medium with an income level in the low-middle range.

Central

The Central bus route includes a large neighborhood loop at its northern end and a CBD connection along North Main. The loop is through a basically residential area with interspersed neighborhood commercial activity. The residential density is low to medium and the income level generally low. The CBD connection runs through a low-density, low-income area which includes strip commercial and CBD fringe activities.

College

The College Avenue bus route includes a small loop at the southern section and a long extension into the CBD which bends from James Avenue to College Avenue to Henderson Street. The southern section of the line is largely through a medium-density, middle-income residential area with some commercial nodes at the major intersections. The northern segment includes a gradual shift to predominantly commercial and warehousing uses as one approaches the CBD. The residential density is medium to high and the income generally low.

Handley-East Lancaster

This route is composed of a large loop at the far east side of the line and a long CBD connection along East Lancaster Avenue. The loop area includes multiple family dwellings and strip commercial activities. The neighborhood is a middle-income, medium-density housing area. The East Lancaster connection includes surrounding commercial, residential, and fringe CBD activities. This area is largely a low-density, low-income neighborhood.

El Campo

The El Campo route extends from a large loop at the southern section of the route and connects to the CBD along Montgomery and West Lancaster. The loop section is largely through an area of single family dwelling units interspersed with apartments. The southern part also includes warehouses, small offices, and some low-income housing. The housing density is medium and the income level is low to middle. The land use along the downtown connection includes CBD fringe activities, offices, warehouses, commercial activities, and a stockyard. The housing density is generally low, as is the income level of the population.

Evans-Oakhurst

The Evans-Oakhurst route includes two large segments: one radiating to the south of the CBD along Evans Avenue and the other extending northeast along Oakhurst and Riverside. The Evans segment includes a loop and the connection to the CBD. The land use includes mixed residential, commercial, and warehousing activities. The housing density is basically medium, while the income ranges from low to middle and generally decreases as one approaches the CBD. The Oakhurst-Riverside segment of this line includes two large loops. Land use is greatly diversified with a mixture of commercial, industrial, warehouse activities, and interspersed residential units. Housing density ranges from low to medium and the income level from low to upper-middle in the northernmost sections.

Hemphill

The Hemphill line extends south of the CBD along Hemphill Street and ends in a large loop around Felix, Evans, and Seminary Drive. The loop section passes through an area of single family residential units with mixed industrial and commercial nodes. Housing density is largely medium and the income level is middle. Land use activity along Hemphill Street includes medium-density residential areas, strip commercial, CBD fringe, and warehousing activities. The family income level ranges from medium to low closest to the CBD.

Lakeview

The Lakeview route is among the shortest of those examined. Its layout includes a small loop at the south and a bending route to the CBD. It serves a medium-density, low-income residential area which is interspersed with commercial and warehouse activities.

Polytechnic

The Polytechnic route is composed of a loop at the southern end and a downtown connection along East Rosedale and Vickery Boulevard. The loop area includes single family residential housing, spot commercial activity, and some institutions (Texas Wesleyan College). The housing density is medium and the family income level middle. The CBD extension follows a route through CBD fringe activities, warehouses, and some public housing. The neighborhood has medium housing density with a generally low income.

Ridglea Express

This route runs along the East-West Freeway for approximately half of its mileage. The far western segment of the route forms a loop through a medium-density, middle- to upper-middle income neighborhood. Land use includes apartments, single family dwelling units, strip commercial, and shopping center areas.

T.C.U.

The T.C.U. bus line consists of a large southern loop and a bending connection into the CBD. The loop area is predominantly mixed residential with scattered shopping centers and commercial activity. The housing density is medium and the income level middle to upper-middle. The downtown connection passes by the Texas Christian University campus. The income level of the population ranges from middle around the campus to low near the CBD.

Third Ward-Butler

The Third Ward route (also known as Butler) is located close to the downtown area to the east of the CBD. It serves a compact, low-income public housing area (Butler Housing). As is the case in most public housing areas, the density is high and the income level of the residents is the lowest of the lines studied. The route largely consists of a loop around the housing area and a short extension to downtown.

Wedgewood

The Wedgewood Express serves the residential area at the extreme southern part of the city. The nonstop express section of the line follows Interstate Loop 820 eastward and runs to the CBD along the North-South Freeway. The loop area is composed of mixed residential units and several modern shopping centers. The housing density is low to medium and the income level is middle to upper-middle, the highest of any route in this study. This route has since been discontinued, but the neighborhood continues to be served by line extensions of other routes to the north.

The following chapter examines the various service and ridership characteristics of these 15 bus lines. Chapter IV then describes the impact of the oil embargo on the ridership of each of these lines.

CHAPTER III

ANALYSIS OF BUS LINE VARIABLES

RIDERSHIP CHARACTERISTICS

Data on normal preembargo bus ridership characteristics were obtained from the Fort Worth Transportation Study.[25] This study utilized the results of an onboard survey of 9,800 weekday bus passengers which was taken during the spring of 1971. Inbound transit riders on all lines were given questionnaires (Appendix A) regarding various socio-economic as well as ridership characteristics. The following is a brief description of these results.

Passenger Occupation

The bus survey indicated that CITRAN passengers were most commonly office workers and students (Table III-1). Of the 15 case study lines, the Ridglea Express, El Campo, and Wedgewood routes carried the highest percentages of office workers. Students made up a large percentage of the riders along the Berry, Wedgewood, Third Ward, Central, College, and Polytechnic routes. Domestic workers were most common along the Third Ward, Carswell, and Wedgewood routes, while the Handley-East Lancaster route transported a large percentage of store clerks. An above-average percentage of riders on the Third Ward (11 percent) and Hemphill (6 percent) lines were unemployed.

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[25] City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

TABLE III-1

BUS PASSENGER OCCUPATION*

Bus Line	Office	Factory	Store Clerk	Domestic	Student	Housewife	Retired	Unemployed	Other or No Answer	Total
Angle-Jarvis	7	7	10	12	21	4	0	4	35	100
Berry	0	5	2	7	71	1	0	3	11	100
Carswell	13	9	3	21	14	5	4	3	28	100
Central	11	6	6	2	31	6	10	2	26	100
College	26	7	5	2	26	5	7	4	18	100
Handley-E. Lancaster	29	0	34	5	24	2	0	0	6	100
El Campo	35	5	10	4	13	9	6	3	15	100
Evans-Oakhurst	14	11	8	15	17	6	3	3	23	100
Hemphill	17	15	9	5	15	8	5	6	20	100
Lakeview	16	7	6	12	23	4	5	4	27	100
Polytechnic	24	3	12	5	25	6	1	4	20	100
Ridglea Express	57	2	5	12	13	1	1	0	9	100
T.C.U.	23	2	6	15	13	5	2	5	29	100
Third Ward-Butler	11	0	0	32	32	13	0	11	1	100
Wedgewood	30	0	3	21	41	5	0	0	0	100
Total System (N=6,900)	23	8	7	10	19	7	5	4	17	100

*Percent of respondents.

Source: City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

Passenger Origin-Destination

As Table III-2 indicates, the largest group of inbound bus passengers began their trip from their homes, while their most common destinations were to places for employment. This origin pattern was evident in most of the case study lines, with the exceptions of Carswell where many passengers originated at the Air Force base, and the Handley-East Lancaster line which carried a large proportion of riders returning from work at locations in the East Lancaster area. Along two of the case study lines, the major passenger destination was something other than work. The majority of inbound passengers riding the Berry line were destined for school (TCU) or home, while the Handley-East Lancaster line continued exhibiting its reverse commute pattern with home being the major destination.

Passenger Income

Half of all the bus riders on the total system had a family income of below $6,000 (Table III-3). Notable exceptions among the case study lines were El Campo, Ridglea Express, and TCU, which had larger proportions of their passengers in middle- or upper-income brackets. The Third Ward-Butler line had the largest proportion of low-income riders.

Passenger Age

An analysis of the age of riders indicates that passengers along the majority of lines were most commonly in the upper-middle age group of 45-64 (Table III-4). Carswell

TABLE III-2

BUS PASSENGER ORIGIN-DESTINATION*

Bus Line	Origin					Destination				
	Work	Shop & Business	School	Home	Social & Other	Work	Shop & Business	School	Home	Social & Other
Angle-Jarvis	14	4	6	65	11	52	6	18	6	18
Berry	7	1	39	47	6	19	0	38	36	7
Carswell	9	23	2	1	65	47	13	9	12	19
Central	9	8	13	58	12	39	20	28	4	9
College	14	7	23	48	8	37	9	11	23	20
Handley-E. Lancaster	39	5	22	28	6	40	3	2	51	4
El Campo	1	3	7	46	43	43	13	6	25	13
Evans-Oakhurst	20	3	7	60	10	52	13	10	14	11
Hemphill	24	10	7	49	10	44	13	9	16	18
Lakeview	18	5	11	55	11	47	12	10	18	13
Polytechnic	18	4	19	55	4	48	17	11	18	6
Ridglea Express	31	2	5	47	15	55	2	3	27	13
T.C.U.	35	7	12	40	6	44	12	1	31	12
Third Ward-Butler	37	14	0	45	4	50	4	8	37	1
Wedgewood	20	1	38	39	2	46	11	9	32	2
Total System	22	5	11	49	13	46	12	9	19	14

*Percent of respondents.

Source: City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

TABLE III-3

BUS PASSENGER FAMILY INCOME*

	Under $6,000	$6,000-$10,000	Over $10,000
Angle-Jarvis	62.3	17.1	20.6
Berry	38.5	26.9	34.6
Carswell	53.9	32.0	14.1
Central	50.8	2.9	46.3
College	45.7	22.1	32.2
Handley-East Lancaster	46.5	35.5	18.0
El Campo	32.4	31.4	36.2
Evans-Oakhurst	51.2	29.1	19.7
Hemphill	51.2	29.0	19.8
Lakeview	52.2	29.6	18.2
Polytechnic	49.8	30.5	19.7
Ridglea Express	34.7	20.0	45.3
T.C.U.	32.4	24.2	43.4
Third Ward-Butler	67.3	32.7	0
Wedgewood	50.9	6.6	42.5
Total System	50	28	22

*Percent of respondents.

Source: City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

TABLE III-4

BUS PASSENGER AGE*

Bus Line	15 and Below	16-24	25-44	45-64	65+
Angle-Jarvis	9	3	25	42	16
Berry	21	16	15	28	11
Carswell	28	26	38	5	3
Central	8	26	30	35	2
College	9	24	24	31	10
Handley-East Lancaster	7	6	21	55	12
El Campo	3	20	26	38	13
Evans-Oakhurst	6	26	21	36	8
Hemphill	6	25	24	33	11
Lakeview	2	25	24	27	19
Polytechnic	7	43	8	32	10
Ridglea Express	9	29	26	27	8
T.C.U.	6	26	17	34	15
Third Ward-Butler	3	15	23	23	0
Wedgewood	10	10	11	69	0
Total System	7	26	24	31	11

*Percent of respondents. Figures do not equal 100 percent due to no responses.

Source: City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

and Berry carried an abnormally high percentage of younger riders, while Lakeview and Angle-Jarvis carried higher than average proportions of elderly (65 years of age or more).

Passenger Automobile Ownership and Drivers Licenses

The onboard passenger survey asked riders questions concerning the number of cars in their household, car availability, and the possession of drivers licenses. It was found that most families of the passengers had at least one automobile and nearly half (48 percent) had two or more cars (Table III-5). The Central, Polytechnic, and TCU lines had exceptionally high proportions with no cars, while those on Berry, Ridglea, and Wedgewood tended to have two or more automobiles per family.

The question on car availability indicated that 80 percent of the total riders had no car available at that time and were thus essentially captive riders. Only the Ridglea Express line carried a large proportion (47 percent) of riders who did have a car available.

A large majority (64 percent) of the riders possessed no drivers license. The Ridglea Express and El Campo routes were the only case study lines carrying a majority of passengers with drivers licenses.

TABLE III-5

BUS PASSENGER AUTOMOBILES AND DRIVERS LICENSE*

Bus Line	Number of Cars In Household 0	1	2+	Car Available Yes	No	Possess Drivers License Yes	No
Angle-Jarvis	2	40	58	18	82	19	81
Berry	2	19	79	27	73	25	75
Carswell	1	37	62	16	84	34	66
Central	39	26	35	10	90	17	83
College	3	41	56	24	76	42	58
Handley-East Lancaster	2	44	54	17	83	29	71
El Campo	3	36	61	32	68	55	45
Evans-Oakhurst	1	48	51	16	84	38	62
Hemphill	18	50	32	20	80	33	67
Lakeview	2	58	40	18	82	31	69
Polytechnic	42	43	15	19	81	29	71
Ridglea Express	3	21	76	47	53	62	38
T.C.U.	35	45	20	24	76	40	60
Third Ward-Butler	21	46	33	4	96	18	82
Wedgewood	4	20	76	24	76	30	70
Total System	7	45	48	20	80	36	64

*Percent of respondents.

Source: City of Fort Worth, "Bus Surveys and User Characteristics", Fort Worth Transportation Study (Fort Worth, Texas: City Planning Department, February 1972).

BUS CORRIDOR CHARACTERISTICS

An examination of the population characteristics along the bus line service area (based on a $\frac{1}{4}$ mile distance on each side of the bus route, as commonly used by transit planners) can be used to describe the neighborhoods from which potential riders may be attracted. Table III-6 provides a comparison of the 15 case study line corridors with regard to population, average family income, percent of the population using an auto to work, and the percent of the service area population who work in the CBD. The table indicates a great range in neighborhood income along the various line corridors. The average income along the Wedgewood line was the highest ($13,538), while the income level along the Third Ward-Butler ($3,100) and Lakeview ($4,935) corridors was the lowest.

Additional data regarding the percentage of workers who use an auto to reach their place of employment indicated that only along the Third Ward-Butler line were auto users not in the majority. The areas around the Wedgewood, Ridglea, and Angle-Jarvis lines were heavily dependent (over 90 percent) on auto use.

The corridor variable indicating the percentage of neighborhood workers who are employed within the CBD shows much variance between the service areas. Over 18 percent of the workers living in the Third Ward-Butler service area worked downtown as compared to less than 5 percent along the Wedgewood, Ridglea, Handley-East Lancaster, and Angle-Jarvis lines. And, the final variable examined indicates that the maximum route distance to the CBD ranged from 1 to 18 miles.

TABLE III-6

FORT WORTH BUS CORRIDOR CHARACTERISTICS*

Bus Line	Total Population (1970)	Average Family Income (1970)	Percent Using Auto to Reach Work (1970)	Percent CBD Workers (1970)	Maximum Distance to CBD (Miles)
Angle-Jarvis	17,800	$ 6,979	94	4.1	7
Berry	36,700	10,887	85	8.0	10
Carswell	18,200	7,066	80	4.9	14
Central	13,700	5,761	81	9.1	5
College	30,500	7,289	83	10.0	10
Handley/East Lancaster	30,500	9,595	89	3.8	13
El Campo	18,200	9,398	89	7.1	6
Evans-Oakhurst	54,400	7,508	83	8.1	8
Hemphill	36,800	7,462	83	9.3	11
Lakeview	13,700	4,935	71	7.4	4
Polytechnic	28,300	6,771	84	11.8	8
Ridglea Express	12,700	10,938	93	3.6	16
T.C.U.	55,200	10,020	84	6.5	11
Third Ward-Butler	2,900	3,100	50	18.5	1
Wedgewood	11,300	13,538	96	3.3	18
Total City	393,476	$ 9,271	88%	8.8%	-

*The area within one-quarter mile on each side of a bus route.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population and Housing, Census Tracts, Fort Worth, Texas, Standard Metropolitan Statistical Area (Washington, D.C.: U.S. Government Printing Office, 1972).

LINE SERVICE CHARACTERISTICS

Table III-7 provides a comparison of bus service characteristics and patronage data for the case study lines. The average bus speed ranged from a low of 9.1 miles per hour along the Angle-Jarvis and Central lines to highs along the Wedgewood (20.9 miles per hour) and Ridglea (18.9 miles per hour) express lines. The average peak-hour bus headway (the time between bus arrivals at stops) was a short 12 minutes along the Lakeview line, but over one hour along the Carswell and Wedgewood lines.

The table further compares the normal yearly (1970) passenger volume for each line. Total ridership was the greatest on the Hemphill and Evans-Oakhurst lines and the least along the Wedgewood and Handley routes. The number of passengers per bus-mile was the greatest on the Third Ward-Butler (2.6) line and least on the Berry (.77), Handley (.85), and Wedgewood (.94) routes.

The final variable listed on Table III-7 represents the relative change in passenger ridership from 1966 to 1970. The systemwide trend in passenger decline appears to be quite obvious with most lines decreasing by 20 to 50 percent during this period. Only the Third Ward-Butler line, with a relatively slight 4.9 percent drop, did not experience a sharp decline in ridership during the preembargo period.

TABLE III-7

BUS LINE SERVICE AND PATRONAGE CHARACTERISTICS

Bus Line	Average Bus Speed (mph)	Average Peak Headway (min)	Passengers Carried (1970)	Passengers Per Bus Mile (1970)	Change in Total Ridership 1966-1970 (percent)
Angle-Jarvis	9.1	30	148,822	1.26	-25.8
Berry	11.3	30	74,813	.77	-26.0
Carswell	15.9	60	246,862*	1.34	-26.0
Central	9.1	40	102,582*	1.16	-40.8
College	13.0	24	237,829	1.85	-31.9
Handley-East Lancaster	14.8	30	51,310*	.85	-54.9
El Campo	15.1	30	363,633	1.34	-23.3
Evans-Oakhurst	14.2	20	920,800*	2.14	-29.7
Hemphill	12.1	15	1,229,594*	2.28	-23.4
Lakeview	9.3	12	726,796	2.07	-28.2
Polytechnic	12.7	20	250,369	1.77	-31.2
Ridglea Express	18.9	30	96,682	1.44	-33.2
T.C.U.	13.5	15	478,713	1.74	-35.8
Third Ward-Butler	10.0	30	115,651	2.96	- 4.9
Wedgewood	20.9	60	37,326	.94	-35.3
Total System	N.A.	N.A.	6,912,020	1.88	-27.8

*Includes segments of other lines.

Source: Alan M. Voorhees and Associates, Inc., Fort Worth Bus Operational Study, Appendix 2, "Transit Design Criteria and Route Reconnaissance" (Fort Worth, Texas: September 1971).

CHAPTER IV

OIL EMBARGO PERIOD BUS RIDERSHIP CHANGES

When examined on a yearly basis (as shown on Table II-6), the impact of the energy crisis on CITRAN ridership is barely perceptible. Total bus ridership during 1974 actually declined (-0.5 percent) from 1973 levels. However, in view of the historical trend of passenger decline (an average decrease of 2.6 percent per year), this drop was not as severe as would have been anticipated under normal conditions.

An examination of monthly revenue passenger data for the total city bus system indicates that there was a slight increase in ridership during most months of the embargo period (Table IV-1). As with national ridership patterns, these local changes were most significant in that they showed an abrupt reversal in trends from the patronage declines experienced during preembargo months. Ridership during the preembargo month of September, 1973, for example, decreased 22 percent. By contrast, during the first full embargo period month, November, 1973, ridership increased by 2 percent. During the month of December, however, ridership declined by 15 percent. This decrease could possibly be explained by a general decline in travel for seasonal Christman shopping purposes at a time when the national economy was entering a recessionary period.

As Table IV-1 shows, ridership increased at greater rates during the months immediately following the end of the embargo than at the peak of the shortage. This could be

TABLE IV-1

TOTAL BUS SYSTEM RIDERSHIP CHANGES

Month	Revenue Passengers Previous Year	Revenue Passengers Embargo Period	Percent Ridership Change	Gasoline Price Change
September, 1973	461,432	358,981	-22	-
October (Embargo begins)	392,032	343,822	-12	N.A.
November	427,409	437,386	+ 2	+3.7
December	396,909	337,261	-15	+4.7
January, 1974	329,895	332,766	+ 1	+9.2
February	364,666	361,989	- 1	+7.7
March (Embargo ends)	458,926	463,118	+ 1	+8.5
April	353,941	372,665	+ 5	+3.3
May	444,096	461,270	+ 4	+0.8

Sources: From data supplied by Transportation Department, CITRAN, and U.S. Bureau of Labor Statistics, "Consumer Prices" (Dallas, Texas: Region Six Bureau of Labor Statistics, 1973, 1974).

explained by the continued rise in gasoline prices even after the embargo was lifted. During the final embargo period month of March, 1974, for example, ridership increased approximately 1 percent, compared to an increase of over 5 percent during April.

CASE STUDY LINE RIDERSHIP

A closer examination of the bus system ridership changes by each line presents a much different pattern than that for the total system. As is shown on Table IV-2, the maximum ridership changes on the case study lines ranged from an increase of 94 percent over the same time period during the previous year to a decrease of over 3 percent. More lines experienced a gain (13 lines in this category) than a decline (two lines) in patronage.

The Ridglea Express experienced the greatest ridership increase (94.16 percent), followed by Wedgewood with a 70.24 percent rise. The other lines in this category, Berry (26.75 percent), El Campo (16.93 percent), and College (8.84 percent) sustained more modest increases.

The Angle-Jarvis (-3.54 percent) and Central (-2.42 percent) were the only lines experiencing ridership decreases. Ridership on the Third Ward-Butler (+0.32 percent) and Lakeview (+0.25 percent) lines remained virtually unchanged.

The range of ridership changes was found to be considerable, thereby supporting the primary hypothesis that energy constraints affected each line differently. Through a

TABLE IV-2

CASE STUDY BUS LINE RIDERSHIP CHANGES
DURING 1973-1974 OIL EMBARGO

Bus Line	Maximum Percent Ridership Change*
Angle-Jarvis	- 3.54
Berry	+26.75
Carswell	+ 7.94
Central	- 2.42
College	+ 8.84
Handley	+ 3.69
El Campo	+16.93
Evans-Oakhurst	+ 5.51
Hemphill	+ 1.68
Lakeview	+ 0.25
Polytechnic	+ 4.01
Ridglea	+94.16
T.C.U.	+ 3.69
Third Ward-Butler	+ 0.32
Wedgewood	+70.24

*Monthly ridership changes were determined by calculating the percent ridership change from each corresponding month of the previous year (for example, ridership on the T.C.U. line for December, 1974, was 4.6 percent greater than during December, 1973). The maximum change in each line represents the mean of the two highest monthly changes which occurred during the oil embargo period (October, 1973-March, 1974).

Source: From data supplied by Transportation Department, CITRAN, 1976.

factor analysis process, the following chapter attempts to test the secondary hypothesis by examining the relationships between those changes and the identified characteristics of the lines.

CHAPTER V

CORRELATION OF VARIABLES

Since the principal objective of this exercise is to identify the transit line characteristics which make them conducive to ridership increases under energy restraints, it was determined that a simple factor analysis of each of the identified independent variables (see Chapter III) correlated with the relative ridership change could produce the desired associations. This was accomplished by executing the BMD computer correlation program 02D as developed by the Health Science Computing Facility of UCLA. The results of this operation are outlined below and listed in Appendix B.

POSITIVE CORRELATIONS

Table V-1 lists the variables found to have the highest positive correlation with ridership change. It is interesting to note that the variables associated with the characteristics of high-income neighborhoods and passengers appear to be those most strongly correlated to ridership increases. Preembargo passenger characteristics which indicate a high income (car available, office worker, have drivers license, family income over $10,000) correlate strongly with the tendency for bus line ridership to increase during the embargo period. A strong correlation also exists with the service variables of bus speed and distance to the CBD as well as the corridor characteristics of income and auto users. In sum, it appears that the bus lines which served higher income areas, those farthest

TABLE V-1

POSITIVE CORRELATIONS*

Variable	Correlation Coefficient
Preembargo riders with car available	.8113
Preembargo riders who are office workers	.7550
Preembargo riders possessing a drivers license	.7103
Average bus speed	.6228
Preembargo riders with 2+ cars in family	.5033
Bus line distance from the CBD	.4948
Bus corridor family income	.4786
Preembargo riders with family income over $10,000	.3690
Percentage of workers in bus corridor using auto to work	.3123
Preembargo riders whose destination is work	.2925

*Correlations of maximum line ridership changes with line characteristics.

Source: BMD computer correlation program 02D, Health Science Computing Facility, UCLA.

from the CBD, and those normally carrying a relatively high percentage of upper-income riders tended to experience the largest percentage increase in ridership during the embargo period.

Because the higher-income areas in most cities are also the newer suburban areas located farthest from the Central Business District, it is reasonable to expect a high cross-correlation of income and bus distance. Furthermore, since these suburbs are often connected to the CBD by high-speed highways, bus speed is strongly correlated to distance. A correlation of corridor family income with bus line distance, for example, produced a high coefficient of .8171 while income with bus speed was .7592. Appendix C lists selected variable cross-correlation coefficients.

NEGATIVE CORRELATIONS

A negative correlation was found associated with the variables which generally indicate lower-income passengers and corridors (Table V-2). Relative embargo period ridership gains tended to decline as the proportion of preembargo riders who had no car, no drivers license, were employed, housewives, retired or factory workers, and those with a family income below $6,000 increased. In addition, those lines which carried the highest passenger volumes, passenger/bus mile ratios, and served the largest corridor populations also tended to show little ridership increases. Thus, it may be inferred that ridership levels on the high volume bus lines which generally served the lower-income, "captive" riders of the inner city tended to be minimally affected by the energy constraints of the embargo period.

TABLE V-2

NEGATIVE CORRELATIONS*

Variable	Correlation Coefficient
Preembargo riders with no car available	-.8113
Preembargo riders with no drivers license	-.7103
Preembargo riders with 1 car family	-.4605
Preembargo riders going to shop	-.4448
Preembargo riders who are unemployed	-.3991
Preembargo riders who are housewives	-.3793
Preembargo riders who are retired	-.3077
Preembargo riders with no family car	-.3072
Preembargo riders returning from shopping	-.3063
Preembargo riders going to school	-.2834
Number of passengers per bus mile	-.2777
Preembargo riders who are factory workers	-.2614
Preembargo riders with family income below $6,000	-.1842
Total passengers carried	-.1696
Total bus corridor population	-.1622

*Correlations of maximum line ridership changes with line characteristics.

Source: BMD computer correlation program 02D, Health Science Computing Facility, UCLA.

CHAPTER VI

ANALYSIS OF FINDINGS

The preceding discussion and factor analysis have suggested the following conclusions:

- During this period of energy constraints, bus lines which traversed areas with the highest average incomes tended to experience the largest relative ridership gains.
- During this period, the bus lines which provided the fastest service, i.e., the express lines, tended to experience the largest relative ridership increases.
- The bus lines which extended farthest into the suburbs from the CBD tended to experience the greatest percentage ridership increases.

RIDERSHIP CHANGE AND SERVICE CORRIDOR INCOME

An initial assumption regarding the effect of the energy shortage on income groups might be that low-income persons would be most likely to utilize transit facilities more during than before an "energy crisis". The increased cost of gasoline would make auto travel prohibitive for low-income families, whereas higher-income families could more easily absorb the price increases and would, therefore, be less likely to alter their travel habits.

While it is undoubtedly true that the poor are hardest hit by rising fuel costs since a much larger percentage of their total income is spent for this purpose,[26] the fact that

[26] Fifteen percent of the nation's low-income families with annual incomes of $3,000 or less spend more than 10 percent of their income for gasoline compared to only 2 percent spent by the highest-income ($24,000+) families; Institute of Social Research, The University of Michigan, "Rising Food and Gas Costs Hit Poor Hardest", IRS Newsletter, Vol. 3, Number 1, Winter 1975, p. 3.

transit utilization is already relatively high among these groups (Table VI-1) indicates that the market for large increases of new riders in low-income neighborhoods probably holds less potential than in higher-income areas where normal transit utilization is low. This appears to be the case in Fort Worth for, although the absolute number of lower-income persons using the bus more in these corridors may have been greater during the embargo period in relative terms to the normal ridership on these lines, there appeared to be little change. On the other hand, a small influx of new riders on the lines which extend into the higher-income city suburbs and previously carried few riders (Wedgewood, Ridglea) appeared to be statistically more noticeable.

The fact remains, however, that a significant number of higher-income persons did utilize transit more during the energy crisis. This finding is further supported by the NORC national survey[27] taken during this time (Table VI-2) which indicates that a relatively large percentage of higher-income respondents used public transportation more. Here too, the obvious implication may be that the higher-income transit utilization rate was initially much lower.

The factor analysis in Chapter V further supports the significance of corridor income as a variable of new transit ridership. Here, a strong positive correlation of ridership

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[27] Murray et al., The Impact of the 1973-1974 Oil Embargo on the American Household, p. 86.

TABLE VI-1

TRANSIT WORK TRIPS BY INCOME GROUP UNITED STATES

Annual Household Income	Percent Using Transit
Under $3,000	12.8
$3,000 - 3,999	12.5
$4,000 - 4,999	11.6
$5,000 - 5,999	9.4
$6,000 - 7,499	6.9
$7,500 - 9,999	5.9
$10,000 - 14,999	5.1
$15,000 and over	6.5
All	7.2

Source: U.S. Department of Transportation/Federal Highway Administration, Nationwide Personal Transportation Study, Home-to-Work Trips and Travel, Report No. 8 (Washington, D.C.: August 1973), p. 28.

TABLE VI-2

PERCENT USING PUBLIC TRANSPORTATION MORE BY TOTAL FAMILY INCOME - UNITED STATES

	Under $6,000	$6,000 - $10,000	Over $10,000	Total
Percent of income group	1.10 (N=453)	2.91 (N=446)	2.82 (N=1,346)	2.49 (N=2,245)

Source: James Murray et al., The Impact of the 1973-1974 Oil Embargo on the American Household (Chicago, Illinois: National Opinion Research Center, University of Chicago, December 1974), p. 86.

increase with higher neighborhood income and the percentage of persons normally using an auto to travel to work was identified. Figure VI-1 shows that, as the corridor income along the case study bus lines rose, the percentage of new riders tended to increase.

An analysis of the Urban Panel poll[28] of local residents further suggests that certain low-income groups in Fort Worth also rode the bus more and undoubtedly contributed to the ridership increases along some lines. As Table VI-3 indicates, an exceptionally high percentage of domestic workers used the bus more during this time. Likewise, the factor analysis identified strong positive correlations with two preembargo rider occupations: office workers and domestics.

The conclusion of these findings suggests that ridership increases on the bus lines were largely a result of new patronage by higher-income office workers who previously drove their automobiles to downtown destinations, and greater transit utilization by lower-income domestic workers destined for these higher-income neighborhoods. Those lines which experienced decreases in ridership merely continued the historical downward trend in passengers since there were insufficient infusions of these new rider groups to significantly affect ridership levels.

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[28] North Central Texas Council of Governments, Urban Panel Project.

FIGURE VI-1

THE RELATIONSHIP BETWEEN OIL EMBARGO PERIOD TRANSIT RIDERSHIP CHANGES AND THE SERVICE AREA INCOME, CITRAN, 1973-1974

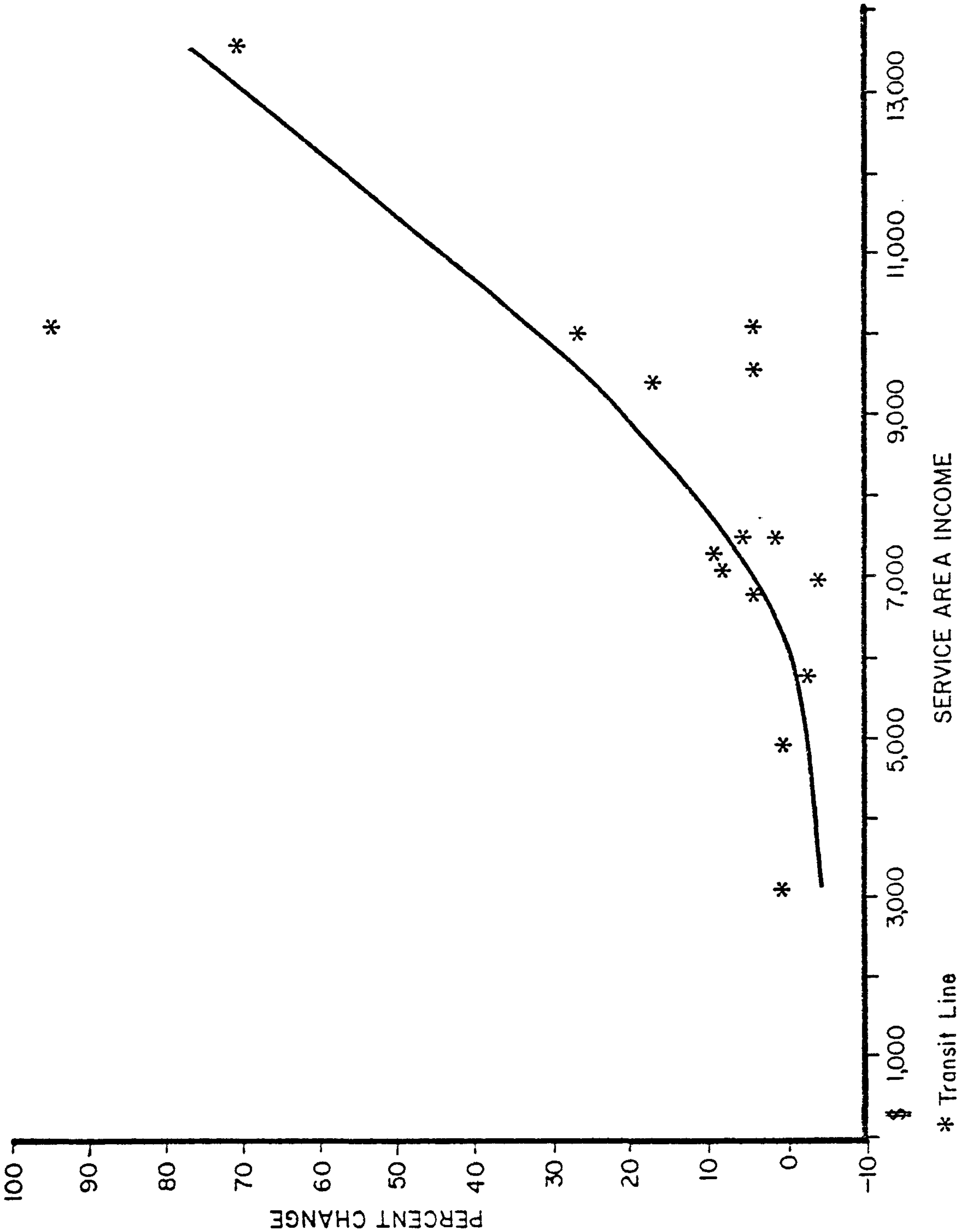


TABLE VI-3

PERCENT USING PUBLIC TRANSPORTATION MORE BY OCCUPATION FORT WORTH URBAN PANEL RESPONDENTS

	Professional, Technical	Sales	Clerical	Operatives, Industrial	Laborers, Farm	Service Workers	Domestics	Handicapped, Retired, Student, Housewife, Other	Total
Percent of work group	2.6	1.9	1.9	2.5	5.9	15.0	20.0	4.0	4.2
Size of work group	190	52	52	40	34	40	10	276	694

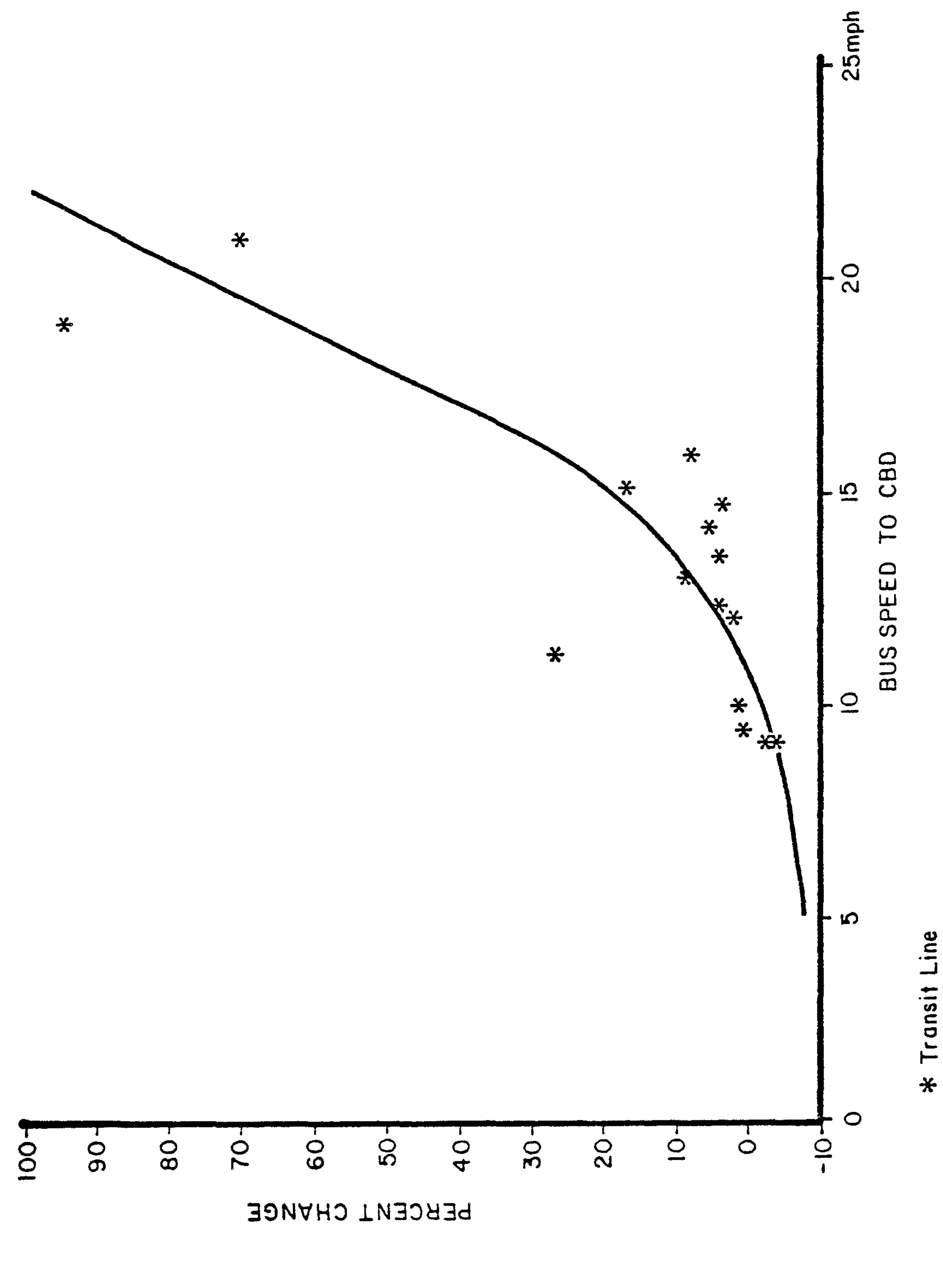
Source: North Central Texas Council of Governments, Urban Panel Project (Arlington, Texas: Transportation Department, September 1976).

EFFECT OF SERVICE ON RIDERSHIP CHANGES

The factor analysis of bus line variables suggests that the type of bus service provided was closely correlated with the changes in transit ridership. Those lines which increased ridership by the greatest percentage during the embargo period were the Ridglea and Wedgewood "express lines". These lines were, moreover, characterized by few stops and infrequent headways. Figure VI-2 illustrates this relationship between ridership changes and the speed of the bus into the Central Business District.

FIGURE VI-2

THE RELATIONSHIP BETWEEN OIL EMBARGO PERIOD
TRANSIT RIDERSHIP CHANGES AND THE BUS SPEED
CITRAN, 1973-1974



While it may be pointed out that this is an obvious conclusion since these express lines also serve generally high-income areas, the other lines which significantly increased ridership (Berry, El Campo, etc.) likewise operated at relatively high speeds.

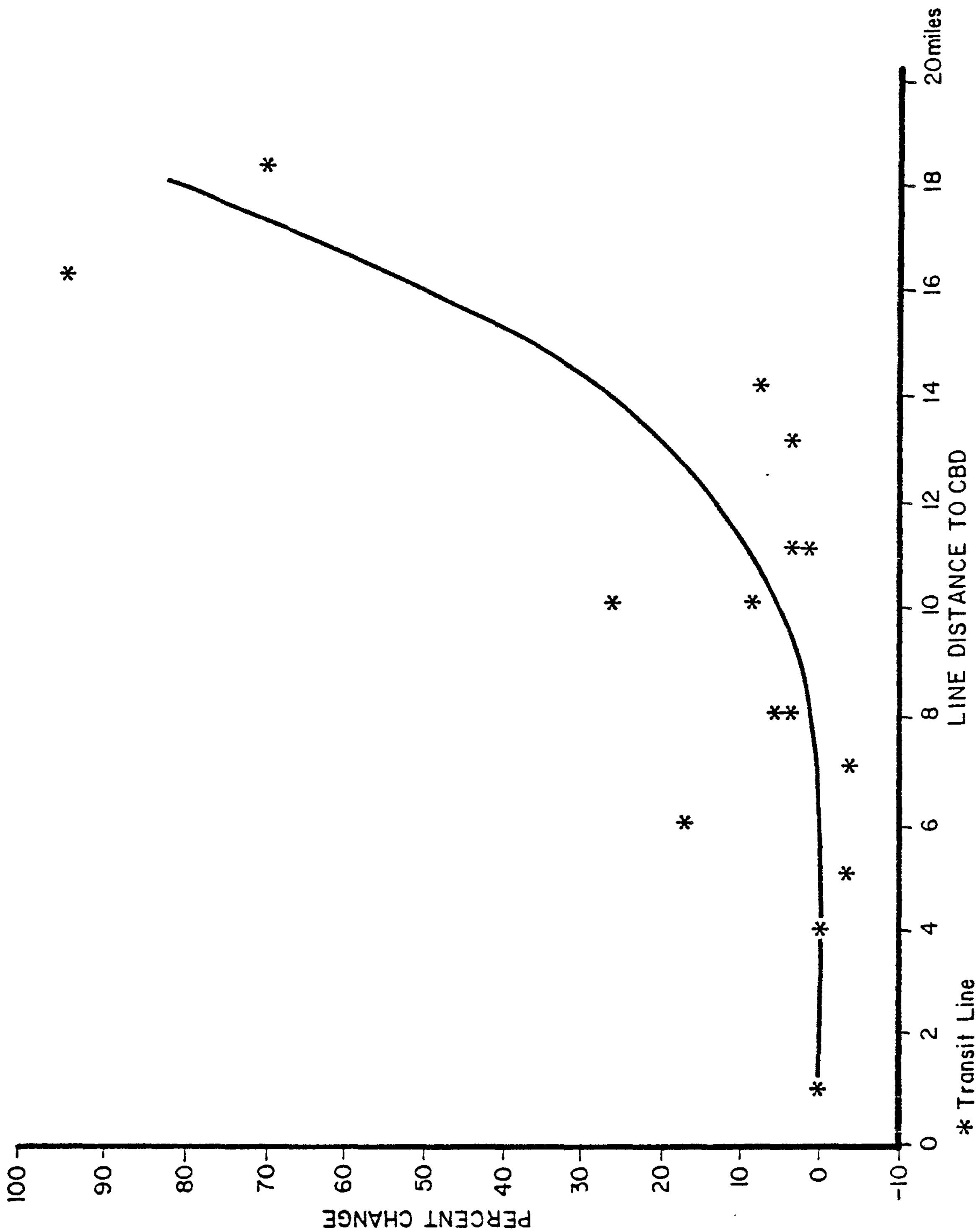
The implication, therefore, is that bus service, particularly travel speed to the major destination (here, the CBD), is a very important variable in attracting new riders during an energy shortage situation. It appears that if a transit alternative exists which is competitive with the auto travel time, commuters are more likely to abandon their autos for this service.

EFFECT OF DISTANCE ON RIDERSHIP CHANGES

Another noteworthy finding suggests that the farther a bus line extended into the city suburbs from the CBD, the greater the percentage increase in bus riders during this period of gasoline shortages. As Figure VI-3 shows, the bus lines which increased ridership the most were those which served neighborhoods located the greatest distances from downtown Fort Worth. This implies that commuters (both inbound professionals and outbound domestics) who had the greatest distances to drive (and, hence, more gasoline to purchase) were more likely to utilize transit as gasoline became more difficult to purchase and more expensive.

FIGURE VI-3

THE RELATIONSHIP BETWEEN OIL EMBARGO PERIOD TRANSIT RIDERSHIP CHANGES AND THE BUS LINE DISTANCE TO THE CBD, CITRAN, 1973-1974



SUMMARY

To sum, it appears that the factors of corridor income, type of bus service, and distance from the CBD were determinants of the variations in bus line ridership changes which occurred during the "energy crisis". The implications of these findings and their possible application to transit planning will be discussed in the following chapter.

CHAPTER VII

CONCLUSIONS AND IMPLICATIONS TO TRANSIT PLANNING

While the conclusions of this research may be applicable only to the case study, findings from analysis of at least one other transit system have recorded similar results. A contingency plan[29] for the Seattle Metro Transit analyzed the effects of the 1973-1974 energy shortage on that city's transit system. One of its conclusions is that:

> Wide differences in load increases between suburban and city routes were noted. The suburban routes increased loads more uniformly, and the impact was more visible than on city routes.[30]

Bus routes in Seattle increased ridership at varying rates which were comparable to routes with similar characteristics in Fort Worth. Ridership on Metro's suburban routes increased an average of 76 percent, while the load on high-density urban lines increased only 13 percent. These figures appear to be comparable to CITRAN's suburban Wedgewood (+70.24 percent) and the Third Ward-Butler high-density urban line (+0.32 percent) load changes.

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[29] The Municipality of Metropolitan Seattle, An Energy Crisis Contingency Plan for Metro Transit (Seattle, Washington: Seattle Metro Council, November 1975).

[30] Ibid., p. 10.

Additional research on Seattle's transit ridership during this period found that these changes varied not only with each line, but also with the time of the day. Some increased their loads the greatest during peak hours, others during midday, and some during late or early hours, with little evident relationship between these changes and the line characteristics.

The evaluation of the Seattle study was then utilized to develop an energy contingency plan for the system which could identify the lines and during which hours bus service could be curtailed if energy constraints made this action necessary. The implications of this Fort Worth analysis may be applied in a similar manner to planning efforts for that transit system. With additional research on hourly changes, CITRAN could use this data to develop a system of service priorities so that its transit facilities could be utilized on routes and during times with the greatest ridership demands. If, for example, the bus system's fuel supply is limited or cut back through government allocation or spot shortages, it may become necessary to reduce service. Through a prioritized list of service reductions based on considerations of each transit line utilization characteristics such as the load factor, trip purpose, existence of alternate transport modes, and knowledge of ridership changes during this period of energy constraints, decisions could be made which would minimize the adverse effects of these actions on passenger service. Furthermore, the observations of this research might be used to locate other areas of the city where new service could be added during an "energy crisis". The higher-income areas of the city, as identified in Figure II-2, would be prime potential markets for this service.

Thus, the identification of these ridership changes should be an important step in the development of a local energy contingency plan.

Perhaps the most significant implication of this study, however, has been the identification of a market for mass transportation service in suburban areas, even in a relatively low-density urban area as Fort Worth, and especially under economic conditions which restrict fuel availability for private automobiles. While this market remains comparatively small, it nonetheless represents an important diversion from past trends of exclusive auto dependency in many suburban areas. The ability of CITRAN and transit systems in numerous other cities to capitalize on this market potential could indeed be vital to the future prosperity of mass transportation.

APPENDIX A

FORT WORTH BUS STUDY
ON-BUS SURVEY QUESTIONNAIRE

APPENDIX A

FORT WORTH BUS STUDY
ON-BUS SURVEY QUESTIONNAIRE

DEAR BUS RIDER:
The City of Fort Worth is conducting a survey to determine future transit needs for the Fort Worth Metropolitan Area. So that YOUR transit needs are taken into consideration, will you please take a few minutes to answer questions about the trip you are now making. Please drop the completed card in box at door or return it to interviewer. If you do not finish this card here, please complete it later and drop it in any mail box, no postage is required.

№ 9679

THANK YOU
CITY OF FORT WORTH

IF YOU HAVE COMPLETED ANOTHER QUESTIONNAIRE TODAY, PLEASE CHECK THE BOX AND RETURN THE CARD ☐ Col. 39–43

A. I BOARDED THIS BUS AT:

______ & ______
Nearest Corner ☐☐☐☐ Col. 1–4

B. I GOT TO THIS BUS:
(check one box) Col. 5

1. By walking ______ blocks ☐1
2. From another bus. ☐2
   Route name ______
3. In a car which I drove and parked ☐3
4. In a car as a passenger ☐4
5. By another means ______ ☐5

☐☐☐ Col. 6–8

C. BEFORE I GOT ON THIS BUS I CAME FROM:

______ & ______
Nearest Corner ☐☐☐☐ Col. 9–12

D. I CAME FROM
(circle one number)

1. Work or related business
2. Shopping
3. Personal business
4. Social–recreation
5. School
6. Home
7. Other ______

Col. 13 ☐

E. I AM GETTING OFF THIS BUS AT:

______ & ______
Nearest Corner ☐☐☐☐ Col. 14–17

F. AFTER I GET OFF THE BUS, I AM GOING TO:

______ & ______
Nearest Corner ☐☐☐☐ Col. 18–21

G. I AM GOING THERE FOR:
(circle one number)

1. Work or related business
2. Shopping
3. Personal business
4. Social-recreation
5. School
6. Home
7. Other ______

Col. 22 ☐

H. I WILL GET THERE:
(check one box)

By walking ____ blocks ☐1
Another bus ☐2
   Route name ____
Drive car ☐3
Passenger in a car ☐4
Other ______ ☐5

Col.23-26 ☐☐☐☐

I. I USE A BUS: Col. 27–28 ☐☐
(make one entry only)

______ Times a day — or
______ Times a week — or
______ Times a month
(Number)

J. I THINK THE SINGLE MOST AND LEAST IMPORTANT IMPROVEMENT TO THE BUS SERVICE IS:
(check only one box on each side)

MOST IMPORTANT		LEAST IMPORTANT
1	Faster travel time	1
2	More frequent service	2
3	Improved routing	3
4	Comfort, convenience in bus	4
5	Better night service	5
6	Sunday Service	6
7	Shopping Center service	7
8	Special service to ______	8
9	New buses	9
Col. 29		Col. 30

K. MY OCCUPATION IS:
(circle one number)

1. Employed in office
2. Factory worker
3. Store clerk
4. Unemployed
5. Student
6. Housewife
7. Domestic
8. Retired
9. Other ______

Col. 31 ☐

L. I AM:
(check one box)

Male ☐1
Female ☐2

Col. 32 ☐

M. MY AGE IS:
(check one box) Col. 33 ☐

15 or under ☐1
16–24 ☐2
25–44 ☐3
45–64 ☐4
65 or Over ☐5

N. IN MY HOUSEHOLD THERE ARE:
(check one box)

No cars ☐0
One car ☐1
Two cars ☐2
Three cars ☐3

Col. 34 ☐

O. THERE WAS ☐1 / WAS NOT ☐2 A CAR AVAILABLE TO USE FOR MY TRIP
(check one box)

Col. 35 ☐

P. (check one box)

I DO ☐1 / DO NOT ☐2 have a driver's license

Col. 36 ☐

Q. THE TOTAL NUMBER OF PEOPLE LIVING AT MY HOME:
(check one box)

One person ☐1
Two people ☐2
Three people ☐3
Four or more people ☐4

Col. 37 ☐

R. MY YEARLY FAMILY INCOME IS:
(check one box)

Under $3,000 ☐1
$3,000 — $6,000 ☐2
$6,000 — $10,000 ☐3
Over $10,000 ☐4

Col. 38 ☐

PLEASE MAKE ANY SUGGESTION IN REGARD TO THE BUS SERVICE:

APPENDIX B

CORRELATION OF RIDERSHIP CHANGES WITH BUS LINE CHARACTERISTICS

APPENDIX B

CORRELATION OF RIDERSHIP CHANGES WITH BUS LINE CHARACTERISTICS

Variable	Correlation
Bus Passenger Occupation	
Office	.7550
Factory	-.2614
Store Clerk	-.1202
Domestic	.1121
Student	-.1389
Housewife	-.3793
Retired	-.3077
Unemployed	-.3991
Other-No Answer	-.3819
Bus Passenger Origin-Destination	
Origin-Work	.2374
Shop-Business	-.3063
School	-.0805
Home	-.0554
Social & Other	.0495
Destination-Work	.2925
Shop & Business	-.4448
School	-.2834
Home	.2124
Social & Other	.0297
Bus Passenger Income	
Under $6,000	-.1842
$6,000-$10,000	-.0467
Over $10,000	.3690

Variable	Correlation
Bus Passenger Age	
15 and Below	.0394
16-24	.1247
25-44	.0065
45-64	-.0270
65+	-.0815
Bus Passenger Automobiles and Drivers License	
0 Cars in Household	-.3072
1 Car	-.4605
2+ Cars	.5033
Car Was Available	.8113
Car Was Not Available	-.8113
Possess Drivers License	.7103
Did Not Possess Drivers License	-.7103
Bus Corridor Characteristics	
Corridor Population	-.1622
Family Income	.4786
% Using Auto to Work	.3123
% CBD Workers	-.3497
Distance from CBD	.4948
Bus Line Service and Patronage Characteristics	
Average Bus Speed	.6228
Average Peak Headway	.0745
Total Passengers Carried	-.1696
Passengers Per Bus Mile	-.2777
Ridership Change - 1966-1970	-.0409

Source: BMD computer correlation program 02D, Health Science Computing Facility, UCLA.

APPENDIX C

CROSS-CORRELATION OF SELECTED BUS LINE CHARACTERISTICS

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CROSS-CORRELATION OF SELECTED BUS LINE CHARACTERISTICS

Variable	Correlation
Family Income with:	
Distance from CBD	.8171
Corridor % Using Auto to Work	.7776
Average Bus Speed	.7592
Bus Passenger Car Available	.6828
Bus Passenger Income Over $10,000	.6546
Bus Passenger Office Worker	.4688
Bus Passenger with Drivers License	.4310
Bus Speed with:	
Distance from CBD	.8350
Family Income	.7592
Bus Passenger with Drivers License	.6132
Corridor % Using Auto to Work	.5211
Distance from CBD with:	
Average Bus Speed	.8350
Family Income	.8171
Corridor % Using Auto to Work	.6873
Bus Passenger with Drivers License	.4041

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