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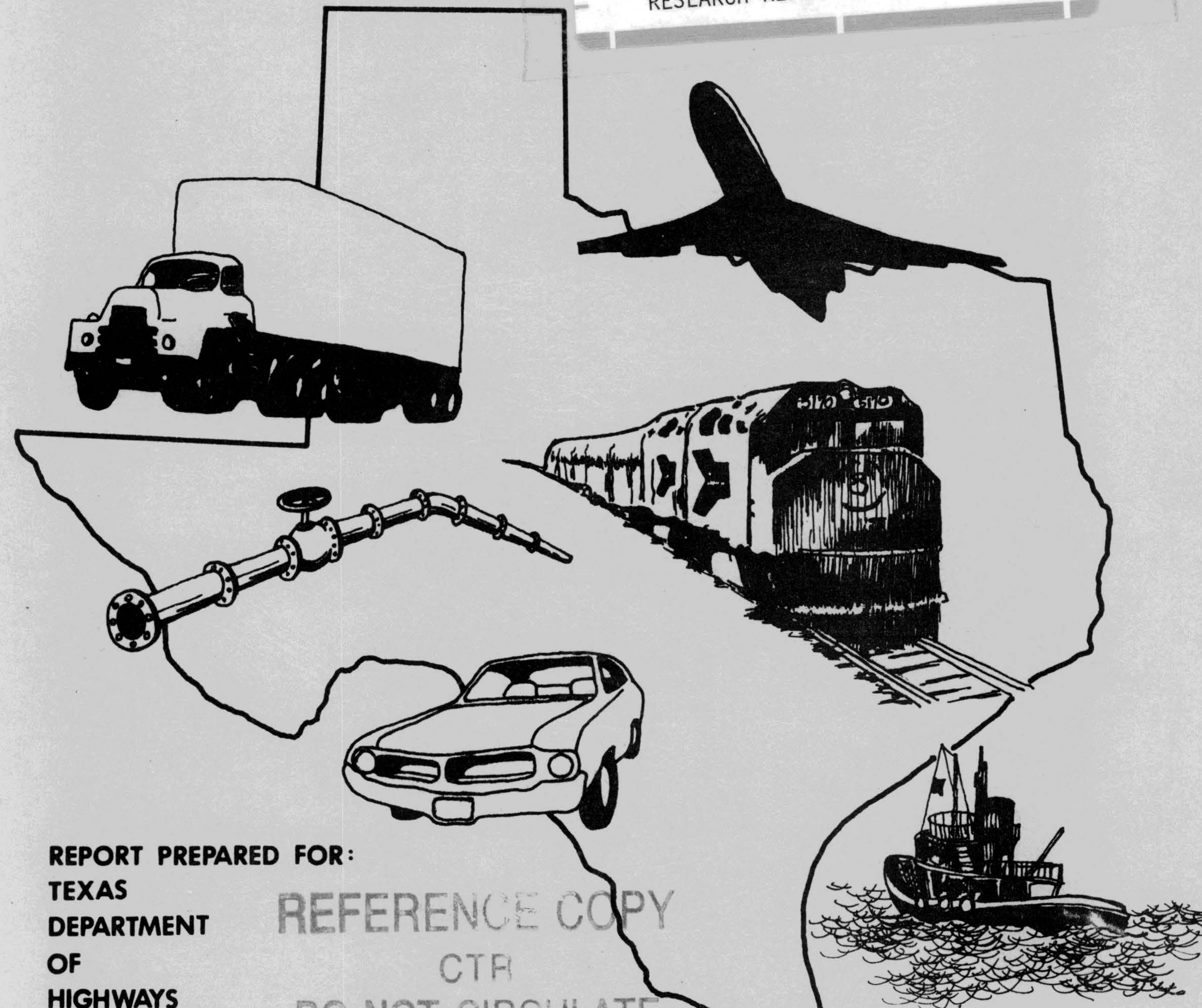

REPORT PREPARED FOR:
TEXAS
DEPARTMENT
OF
HIGHWAYS
AND
PUBLIC
TRANSPORTATION

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY

FORECASTS OF PASSENGER AND FREIGHT TRANSPORTATION EXPENDITURES IN TEXAS

by

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Report 268-1

Transportation Costs and Resources

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STATE DEPARTMENT OF HIGHWAYS
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TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY
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EXECUTIVE SUMMARY

This report presents forecasts of Texas' transportation "bill" for the years 1976-2000. These forecasts represent expenditures for transportation by the private sector in Texas. They were derived using econometric models that utilized estimates of previous transportation bills and data on Gross Texas Product, real gasoline prices, Texas Interstate Highway miles, U.S. unemployment rates, and Texas population.

The future economic environment suggested by forecasts of increasing GTP, decreasing real gasoline prices, increasing Texas interstate miles, and decreasing unemployment influences the forecasted transportation expenditures in the state. These variables, together with forecasted increases in Texas population, imply that transportation expenditures in general will increase in the future.

The forecasts of the Texas transportation bill suggest that several of the passenger transportation modes (namely rail passenger as well as bus, taxi, and transit) would virtually cease to exist before the year 2000 without public subsidies. Total expenditures for each of the other passenger transportation modes, on the other hand, are expected to increase by 2000. For example, per capita expenditures in constant dollars for passenger transportation in Texas are forecasted to increase from approximately $750 in 1975 to about $1,680 by 1995. Expenditures for each of the freight transportation modes are forecasted to increase. The per capita expenditures in constant dollars for freight transportation in Texas are forecasted to increase from about $720 in 1975 to approximately $1,150 in 1995.

Analysis of the Texas passenger transportation bill indicates that of each dollar spent for passenger transportation in Texas approximately 88.9 cents were spent on private automobile transportation in 1965. By 1975, almost 89.6 cents of each passenger dollar were spent for private auto transportation. The forecast of the Texas passenger bill shows that by 1995 approximately 90.6 cents of each passenger dollar will be spent for private auto transportation.

The estimates of the Texas freight transportation bill for 1965 show that approximately 69.9 cents of each dollar spent for freight transportation went to truck transportation. In 1975, truck freight transportation received about 76.1 cents of each freight transportation dollar. The forecasts indicate that by 1995, approximately 86.1 cents of each freight dollar will be spent on truck transportation in Texas.

Analysis of the Texas transportation bill indicates that both highway passenger and highway freight modes dominate transportation expenditures. In 1965, the expenditures for transportation by highway modes were 80.6 percent of the total state's transportation bill. By 1975, the highway mode's share of the total Texas transportation bill had increased to 84.0 percent. The share of the Texas transportation bill spent on auto and truck transportation will increase relative to the share spent on non-highway movement of passengers and freight. For example, in 1985, 1995, and 2000, the expenditures by the private sector for highway transportation are 87.7 percent, 89.4 percent, and 90.1 percent, respectively, of the total transportation bill. The trend of increasing highway mode shares of the total bill suggests that highway freight and highway passenger transportation will become more significant in the Texas economy.

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INTRODUCTION

This study extends previous research to determine the influence of transportation on economic activity in Texas [1]. In the previous study, the economic implications of transportation were highlighted by the relationship between private sector expenditures for transportation and economic output in the state. This was shown by deriving and comparing annual estimates of gross Texas output and transportation expenditures in Texas from 1959 through 1975.

The aim of this study is to establish the relationship between transportation expenditures and economic activity and to use these relationships in conjunction with forecasts of economic activity to estimate the level of future transportation expenditures in the state. Therefore, where the economic significance of transportation is the subject of the previous study, the economic relations of transportation and their implications for Texans in the future are the subjects of this research.

The analysis will proceed with a presentation of the historical data of transportation expenditures and Gross Texas Product. This data shows the historical relationship between transportation and economic activity in the state. The economic significance of transportation is also emphasized by the presentation of data on direct employment in Texas transportation from 1959 through 1975.

This is followed by a presentation of forecasting methodology which documents the procedures used to derive forecasts of the transportation expenditures in the state. Next, the relevant indicators of economic activity that were used in the analysis of the historical transportation expenditure data as well as the forecasts of future transportation expenditures are described. These indicators include Gross Texas Product, fuel prices, unemployment, and miles of Texas Interstate Highways. The estimators of the Texas transportation bill which were derived from the analysis of historical data are then presented. These estimators show the specific relationships between transportation expenditures in the state and the indicators of economic activity in Texas.

Finally, estimates and analysis of future private sector transportation expenditures are given. In this section, the implications of the forecasts for the various transportation modes are also presented.

THE TEXAS TRANSPORTATION BILL

For several years the Transportation Association of America (TAA) has conducted studies at the national level to estimate the nation's freight and passenger bills. The result of these national studies are found in the publication Transportation Facts and Trends which shows freight and passenger bills by transportation mode. In using the TAA method of calculating transportation costs, the perspective that is taken is essentially from the viewpoint of the private sector of transportation (See Appendix A).

This technical note presents the results of the TAA methodology applied to the determination of state level estimates for passenger and freight bills. The TAA approach was selected on the grounds that the results would encompass the private transportation sector and that the data would be applicable to time-series analysis.

Estimates of the Texas transportation bill in current dollars for the years 1959 through 1975 are presented in Tables 1 and 2. Table 1 includes the passenger bill and Table 2 contains the freight bill components of the total transportation expenditures in Texas (see the Appendix A for a detailed description of the methodology used in the estimation of the Texas transportation bill). Under the freight and passenger bill headings, individual mode total expenditures in Texas are arrayed in columns. Each yearly passenger bill is composed of the private transportation sector bill, which includes the private automobile and private aviation expenditures. Ten major components which comprise the total automobile bill are listed. The passenger bill contributions of for-hire passenger modes such as bus, taxi, transit, school bus, railroad and commercial aviation are presented after the private transportation subtotal. The total passenger bill for the state is shown by the grand total of private and for-hire passenger expenditures. Current dollar Gross

Table 1

TEXAS PASSENGER TRANSPORTATION BILL
(In Millions of Current Dollars)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
<u>Private Transportation</u>																	
Auto																	
New and Used Cars	$ 1,126.2	$ 1,041.4	$ 976.2	$ 1,250.5	$ 1,422.6	$ 1,364.9	$ 1,513.1	$ 1,717.6	$ 1,759.8	$ 1,782.0	$ 2,118.4	$ 2,286.6	$ 2,314.1	$ 2,947.3	$ 3,474.8	$ 3,456.5	$ 4,841.4
Auto Repair	330.6	345.9	340.1	354.2	375.8	439.1	463.9	597.8	533.7	604.6	687.2	778.0	882.1	994.5	1,106.3	1,244.4	1,284.6
Gasoline	907.3	993.8	1,010.6	1,013.3	1,023.3	1,109.5	1,180.8	1,265.8	1,340.8	1,440.4	1,536.5	1,731.9	1,862.5	1,999.0	2,202.7	2,726.2	3,168.5
Registrations	55.8	58.0	59.9	63.1	66.1	69.1	72.5	75.7	78.6	89.1	94.8	98.7	103.9	110.0	117.2	120.8	125.4
Operators Licenses	3.0	3.4	3.9	5.8	9.5	10.8	10.1	6.6	6.0	10.4	11.6	5.5	9.0	8.9	10.8	11.4[r]	11.6
Tolls	4.2	3.5	5.5	6.2	6.6	7.3	8.0	9.0	10.2	11.5	17.3	14.9	15.9	17.1	18.1	16.9[r]	17.8
Fine and Penalties	9.2	11.1	10.7	11.6	12.7	3.2	20.5	21.4	23.0	23.4	25.9	25.7	27.2	29.2	32.3	37.2[r]	40.1
Parking	4.5	4.1	4.0	3.9	3.6	3.5	3.4	3.3	3.4	3.4	3.7	5.8	5.3	5.0	7.2	5.8[r]	7.5
Insurance	148.3	141.2	138.3	161.3	166.7	176.7	183.9	216.4	248.5	245.0	258.8	290.5	391.7	429.7	349.2	354.0	297.5
Interest	168.9	156.2	146.4	187.6	213.4	204.7	227.0	257.6	264.0	267.3	317.8	343.0	347.1	442.1	521.2	518.5	726.2
Total Auto	2,757.9	2,758.7	2,695.6	3,057.4	3,300.3	3,388.8	3,683.1	4,171.3	4,268.0	4.477.2	5,071.9	5,580.6	5,958.7	6,982.9	7,839.8	8,491.7[r]	10,520.6[r]
General Aviation	28.9	30.9	30.4	31.5	34.1	38.8	48.2	62.6	61.4	68.1	81.0	103.6	119.0	119.4	144.8	178.7	184.3
Total Private Transport	2,786.8	2,789.6	2,726.0	3,088.9	3,334.4	3,427.6	3,731.3	4,233.9	4,329.4	4,545.3	5,152.9	5,684.2	6,077.7	7,102.3	7,983.6	8,670.4[r]	10,704.9[r]
<u>For-Hire Transportation</u>																	
Bus, Taxi and Transit	98.8	101.3	99.2	102.2	101.0	105.5	107.8	112.1	118.0	131.1	136.9	143.3	149.6	150.9	154.5	165.2	168.6[r]
School Bus	15.5	15.5	18.5	19.8	19.9	20.2	22.4	23.5	25.4	27.4	29.4	33.6	33.3	35.0	42.8	53.3	69.4
Rail	14.4	14.4	13.9	13.4	12.1	10.9	9.2	8.0	6.1	5.9	3.1	2.5	2.8	3.0	3.0	4.7	4.2
Air	162.3	175.5	179.1	192.5	208.0	240.1	272.4	260.2	306.7	351.4	378.3	432.2	456.8	470.8	598.8	737.5	788.8
Total For-Hire Transportation	291.0	306.7	310.7	327.9	341.0	376.7	411.8	403.8	456.2	515.8	547.7	611.6	642.5	659.7	799.1	960.7	1,031.0[r]
Grand Total - Private and For-Hire	$ 3,077.8	$ 3,096.3	$ 3,036.7	$ 3,416.8	$ 3,675.4	$ 3,804.3	$ 4,143.1	$ 4,637.7	$ 4,785.6	$ 5,061.1	$ 5,700.6	$ 6,295.8	$ 6,720.2	$ 7,762.0	$ 8,782.7	$ 9,631.1[r]	$11,735.9[r]
Gross Texas Product	$23,946.0	$24,680.0	$25,785.0	$27,314.0	$28,811.0	$30,948.0	$33,495.0	$36,923.0	$40,089.0	$44,213.0	$48,377.0	$51,465.0	$55,760.0	$62,437.0	$68,976.0	$72,440.0	$87,589.8[r]
Grand Total as % of GTP	12.9	12.5	11.8	12.5	12.8	12.3	12.4	12.6	11.9	11.4	11.7	12.2	12.1	12.4	12.7	13.3	13.4

[r] Revised

Table 2

TEXAS FREIGHT TRANSPORTATION BILL
(In Millions of Current Dollars)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Highway																	
Truck-Intercity	$ 1,345.0	$ 1,328.9	$ 1,382.9	$ 1,399.7	$ 1,439.9	$ 1,616.7	$ 1,606.7	$ 1,814.0	$ 2,013.5	$ 2,087.5	$ 2,005.3	$ 2,258.1	$ 2,594.6	$ 2,917.3	$ 3,218.5	$ 3,525.4[r]	$ 3,658.4[r]
Truck-Local	815.8	827.5	931.2	960.0	1,213.1	1,278.6	1,466.2	1,525.9	1,584.9	1,795.0	1,960.3	2,222.7	2,602.1	3,109.4	3,535.8	3,688.2	4,933.0[r]
Bus	1.4	1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.1	3.6	4.0	4.5	4.6	4.9	5.0	5.3	5.7[r]
Total Highway	2,162.2	2,157.9	2,315.8	2,361.5	2,655.1	2,897.6	3,075.5	3,342.7	3,601.5	3,886.1	3,969.6	4,485.3	5,201.3	6,032.6	6,759.3	7,218.9[r]	8,597.1[r]
Railroads	433.4	410.9	403.3	413.9	420.7	439.2	480.1	522.3	499.0	540.6	585.4	641.6	712.5	772.4	901.8	1,027.4	1,051.1
Water	291.2	301.0	306.7	313.4	324.7	333.2	341.9	355.1	340.7	348.7	357.3	396.0	414.6	444.4	579.1	722.1	758.2
Oil Pipe Line	306.3	304.5	309.4	342.4	339.1	340.3	349.9	372.4	379.3	384.0	430.8	479.7	497.7	522.8	466.8	534.6	650.6
Air	6.3	8.9	11.4	14.2	16.8	19.7	23.9	24.6	29.2	34.3	33.2	35.8	42.7	59.4	56.5	58.0	70.4
Other Shipper Costs	121.6	118.7	119.1	119.2	124.0	126.9	128.6	135.3	130.9	131.4	128.5	122.0	123.0	130.8	147.2	159.6[r]	175.1[r]
Grand Total	$ 3,321.0	$ 3,301.4	$ 3,465.7	$ 3,564.7	$ 3,880.4	$ 4,156.9	$ 4,399.9	$ 4,752.4	$ 4,980.6	$ 5,325.1	$ 5,504.8	$ 6,160.4	$ 6,991.8	$ 7,962.4	$ 8,910.7	$ 9,720.6[r]	$11,302.5[r]
Gross Texas Product	$23,946.0	$24,680.0	$25,785.0	$27,314.0	$28,811.0	$30,948.0	$33,495.0	$36,923.0	$40,089.0	$44,213.0	$48,377.0	$51,465.0	$55,760.0	$62.437.0	$68,976.0	$72,440.0	87,589.8[r]
% GTP	13.9	13.4	13.4	13.1	13.5	13.4	13.1	12.9	12.4	12.0	11.4	12.0	12.5	12.8	12.9	13.4	12.9[r]

[r] Revised

Texas Product (GTP) for each year is given along with the total passenger bill percent of GTP in order to indicate the relative magnitude of the passenger bill and total economic activity in the state.

Total freight bills by year are composed of the freight bills by different modes, including the categories of highway, rail, water, petroleum pipeline, air and other shipper costs. Intercity truck, local truck and bus freight expenditures which comprise the highway bill are presented to facilitate analysis of individual components of the highway mode. The "Other Shipper Costs" category includes the expenditures in the state for freight forwarders and transportation services. As in the passenger bill table, GTP figures are given along with the total freight bill share of Gross Texas Product.

Two points need to be stressed when using the data shown in the tables for the analysis of state transportation expenditures. First, the data represent expenditures by the private sector and do not include the entire transportation bills of federal, state or local governments. Second, the bill in Tables 1 and 2 represents expenditures in Texas for transportation. These expenditures were not necessarily made by Texans; however, the bill represents transactions by the transportation sector which might affect the Texas economy.

These private sector expenditures for transportation indicate the significance of transportation to the state's economy. The estimates show that transportation of passengers and freight has sustained a 25 to 27 percent relative share of GTP. This demonstrates the significance of transportation to the Texas economy in the movement of people and goods in producing the remaining 73 to 75 percent of GTP.

TEXAS EMPLOYMENT IN TRANSPORTATION

The significance of transportation to the Texas economy can also be emphasized by analyzing the jobs created directly by transportation. Table 3 presents the employment estimates in the transportation sector of the state's economy along with estimates of Texas' total non-agricultural employment [2]. The total transportation employment as presented in Table 3 is composed of private transportation employment and for-hire transportation employment categories. Under the private transportation heading, employment in auto dealerships, service stations, auto repair, and service garages are included. Employment in private transportation represents primarily people engaged in service support of automobile transportation as well as truck freight transportation. For-hire transportation employment is composed of employment in trucking and warehousing, local and interurban passenger services, interstate railroad transportation, water transportation, pipeline transportation, air passenger and freight transportation, as well as transportation services. The first two for-hire categories (trucking and warehousing along with local and interurban passenger) represent employment in for-hire passenger and freight movement on Texas highways. The trucking employment data presented in Table 3 do not include private trucking employees. Private trucking employees are those employed directly by a business transporting its own products. Additionally, in trucking firms where the owner operates a truck himself, the owner is not included in the employment statistics.

Transportation employment reported in Table 3, has been declining as a percent of total Texas employment. Over the years included in this study, the percentage of Texas transportation employment to total employment in the state has declined from 9.5 percent in 1959 to 6.1 percent in 1975. Although

Table 3

TEXAS EMPLOYMENT IN TRANSPORTATION
(In Thousands)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Private Transportation																	
Auto Dealers and Service Stations	79.7	78.8	75.5	78.6	80.5	83.2	87.0	89.4	89.8	93.0	95.8	95.7	96.8	105.2	110.7	105.7	107.4
Auto Repair and Garages	9.7	10.4	10.7	11.1	11.5	12.0	12.7	12.7	13.5	14.5	15.5	16.7	16.6	22.5	24.6	26.0	26.7
Total Private Transportation	89.4	89.2	86.2	89.7	92.0	95.2	99.7	102.1	103.3	107.5	111.3	112.4	113.4	127.7	135.3	131.7	134.1
For Hire Transportation																	
Trucking and Warehousing	47.9	48.1	48.0	49.0	48.4	49.7	49.7	56.6	57.2	60.1	67.3	60.6	60.4	64.8	70.4	73.8	70.5
Local and Interurban Passenger	12.1	11.0	10.9	10.7	10.3	9.6	9.1	9.9	9.7	9.8	10.8	10.0	9.8	9.7	10.0	9.6	9.3
Interstate Railroads	43.6	41.6	38.3	37.1	35.1	34.9	33.3	33.3	31.8	30.7	30.0	29.0	28.3	28.6	29.3	29.8	26.8
Water	21.8	21.5	18.8	20.0	22.1	21.6	25.3	21.4	23.9	22.4	10.0	20.3	21.2	21.2	24.1	26.9	23.5
Pipe Lines	9.1	8.2	7.9	8.0	7.1	6.9	6.3	6.5	6.2	5.8	6.5	5.7	5.7	5.4	5.0	4.7	4.9
Air	10.9	11.9	12.3	12.7	12.7	13.5	13.8	16.5	19.9	21.4	25.5	23.4	22.5	22.8	24.4	26.1	24.9
Transport Services	2.9	2.9	3.1	3.3	3.4	3.6	3.5	3.9	4.2	4.1	3.8	4.1	4.4	4.9	5.6	6.9	8.2
Total For Hire Transportation	148.3	145.2	139.3	140.8	139.1	139.8	141.0	148.1	152.9	154.3	153.9	153.1	152.3	157.4	168.8	177.8	168.1
Total Transportation Employment	237.7	234.4	225.5	230.5	231.1	235.0	240.7	250.2	256.2	261.8	265.2	265.5	265.7	285.1	304.1	309.5	302.2
Total Texas Employment* (TE)	2,513.0	2,531.7	2,544.1	2,624.8	2,700.1	2,801.3	2,925.3	3,101.1	3,251.7	3,419.6	3,599.2	4,374.0	4,483.0	4,651.0	4,776.0	4,920.0	4,986.0
Private Transportation As % of TE	3.6	3.5	3.4	3.4	3.4	3.4	3.4	3.3	3.2	3.1	3.1	2.6	2.5	2.7	2.8	2.7	2.7
For Hire Transportation As % of TE	5.9	5.7	5.5	5.4	5.2	5.0	4.8	4.8	4.7	4.5	4.3	3.5	3.4	3.4	3.5	3.6	3.4
Total Transportation As % of TE	9.5	9.2	8.9	8.8	8.6	8.4	8.2	8.1	7.9	7.6	7.4	6.1	5.9	6.1	6.3	6.3	6.1

* Total Non-Agricultural Employment

this percentage has declined, total transportation employment in the state has increased over the long run by approximately 27 percent.

The relative size of for-hire and private transportation employment as measured in Table 3 has also changed. For-hire transportation employment historically has been greater than that of private transportation. Approximately 55.6 percent of total transportation employment occurred in the for-hire category in 1975. The data in Table 3 indicate that the number of employees in private transportation, however, is increasing relative to the number of employees in the for-hire category. Private transportation employment percent of total transportation employment increased from 32.3 percent in 1959 to 41.9 percent in 1975. This implies that the number of people that are required to support highway passenger and freight transportation has increased relative to the employees required to support non-highway transportation of passenger and freight.

Table 3 shows that auto dealers and service station employment has decreased slightly as a share of private transportation employment. The auto dealers and service station employment represented 89.1 percent and 80.1 percent of total private transportation employment for 1959 and 1975, respectively. Such a decline in relative share might be the result of the trend toward gasoline station employment reduction due to more self-service type of gasoline retailing outlets. In late 1971, the Phase I price controls on gasoline and petroleum products went into effect. This placed further pressure on the major oil companies to change their retail outlets to less labor intensive self-service gasoline stations. Additionally, the 1974-1975 recession years following the Arab oil embargo resulted in depressed auto sales and a subsequent reduction in the sales forces of new-car dealers.

The largest share of for-hire transportation employment historically occurs in the trucking and warehousing category. Employment in trucking and warehousing in Texas has grown from 32.3 percent to 41.9 percent of total for-hire transportation employment between 1959 and 1975. Over the same seventeen years, railroad employment has declined from 29.4 percent to 15.6 percent of the total for-hire transportation employment. The increase in trucking industry employment corresponds to an increase both in local and intercity trucking transportation expenditures.

The types of cargoes that are typically carried by truck as compared with the cargoes typically carried by rail might also allude to the decline in rail employment relative to truck transportation employment. Railroads typically transport bulk goods which require little labor intensive handling. Such bulk cargoes are easily routed by computers which save additional manpower in railroad traffic departments. Therefore, the cargoes that require special handling and routing are more frequently carried by truck rather than rail.

Further, rail passenger service declined over the seventeen years observed. Although the passenger service decline started well before 1959, it contributes to the downward trend in Texas railroad employment through 1975. Railroad employment might have diminished over the years included in the table due to reductions in new construction and maintenance. For example, few new rail routes were built over the seventeen years from 1959 through 1975. Additionally, many railroads have allowed their tracks and right-of-ways to deteriorate in recent years.

Employment in for-hire passenger transportation by highway, unlike for-hire freight transportation employment, has decreased from 1959 through 1975. Local and interurban passenger transportation employment has decreased from 8.2 percent of for-hire transportation employment in 1959 to 5.5 percent in 1975. This decrease corresponds to the decrease in constant dollar expenditures for bus, taxi, and transit transportation expenditures in Texas (see "The Economic Significance of Transportation").

Water transportation employment in Texas has remained relatively constant as a percent of total for-hire transportation employment from 1959 through 1975. Employment in pipeline transportation has decreased, however, over these same years.

FORECASTING METHODOLOGY

Analysis of time-series data is the basic technique used in this study to examine the relationship between transportation expenditures in Texas and other economic variables. In time-series methodology, the relationships between historical values of selected variables are the forms of the analysis. These relationships are specified in time-series models and are used to test a theory or hypothesis about the generating mechanism of a process. For instance, the hypothesis that auto expenditures in Texas are a function of real income, real gasoline prices, and population can be tested with a time-series regression model. Also, these models can be used to forecast future values of a series in which inferences about the future values of the transportation bill can be made from the results of an analysis of the historical transportation bill. Results obtained from these time-series models can be used in policy decisions to affect the forecasted outcomes. For example, the forecasts developed from the use of these models might indicate that more highway construction will be required or that freight rates may need to be altered to stimulate growth in a specific sector of the transportation industry.

The underlying assumption critical to time-series analysis is <u>stationarity</u>. That is, the generating mechanism of the regression process is itself assumed to be time-invariant [3] Granger & Newbold. Therefore, neither the form nor the parameter values of the generation procedure described in time-series models change through time. As a result, a coefficient which describes, for example, the relationship between real gasoline prices and transportation expenditures is assumed to remain constant in a time-series model. Although the relationships between the transportation bill and other significant economic variables might be subject to change over time, the models presented in this study use the <u>stationarity</u> assumption in the specification of the relationships between transportation expenditures and economic variables. Therefore, the effects of structural changes in the specified relationships, including governmental policies implemented after the end of the data series in 1975, are not considered in the time-series models. For example, recent policies to stimulate rail passenger and mass transit transportation might influence transportation expenditures in Texas. However, the effects of such policies with respect to changes in transportation expenditures are not considered in the time-series models since the policies were implemented after the historical data series.

Multiple Regression Technique

Estimates of expenditures for transportation in Texas were used as time-series data to derive models for most of the transportation modes analyzed. For a majority of the transportation modes, the historical time-series data of expenditures were regressed with independent variables. The multiple regression technique results in linear relationships specified between each independent variable and the dependent variable. If each of these linear relationships is examined individually, a straight regression line or line of estimates would occur among the observed (historical) values of the dependent variable. Each of these regression lines may be positively or negatively sloped according to the calculated relationship between the independent and dependent variable. Thus, if the real Gross Texas Product (GTP) is positively related to a transportation bill, the bill is expected to increase as GTP increases. Subsequently, forecasts of the bill based upon forecasts of a continuously increasing GTP will also increase with time. Conversely, if a negative relationship between GTP and the transportation bill exists, then the bill will decrease (with time) as GTP increases. If the forecast period is sufficiently long, this negative relationship will result in a zero forecast value for the bill.

In multiple regression models, the individual linear relationships between each of the independent variables and the dependent variable are combined. Therefore, linear estimates or regression lines with these combined relationships do not usually obtain. Zero values of transportation bill forecasts, however, might occur with multiple regression equations if the preponderance of the change in the dependent variable derives from negatively sloped linear relationships specified in the equation. As a result, if the transportation bill has decreased over the range of the historical data from 1959 through 1975, and if no significant changes in the time-series trends occur for the independent variable included in the multiple regression equation, then the transportation bill is expected to become zero at some point in the future.

This report includes forecasts derived from multiple regression models for expenditures by transportation mode in Texas. These forecasts are based on the specified relationships between the transportation bills for each transportation mode and significant independent variables. For some transportation modes, the growth or decline in expenditures over the years from 1959-1975 also occurs over the forecasted years; while in other transportation modes, the trends in expenditures shown by historical data do not occur in forecasted expenditure trends. The direction of the forecasted expenditure trends depends upon:

(1) the independent variables specified in the multiple regression equation; and

(2) the forecasts of the independent variables included in the regression equation.

Multiple Regression Models

The estimators or models derived by multiple regression techniques typically take the general form:

$$Y_i = B_o + B_{i1}X_{i1} + \ldots + B_kX_{ik}.$$

where Y is the dependent variable to be estimated; X_1 through X_k are the independent variables; B_o through B_k are the regression coefficients; and i is the observation. The equation in this form can be used to estimate the i^{th} observation of Y_i given the i^{th} observation of the independent variable.

Multiple regression requires that the number of explanatory variables K is greater than one. If an estimator of the air passenger bill includes GTP and gasoline prices as independent variables, then K = 2. If the air passenger bill estimator, on the other hand, includes only one independent variable, say GTP, the model is a simple regression equation.

In the general form of the multiple regression equation shown above, B_o is the intercept coefficient. This term represents the estimate of the dependent variable when each of the independent variables is equal to zero. As a result, the intercept coefficient remains constant regardless of the value of an observation in the regression model.

The coefficients B_1 through B_k are called partial regression coefficients since each explains only a portion of the variation in the estimate of the dependent variable Y. For example, the coefficient B_k represents the change in Y corresponding to a unit change in the K^{th} independent variable (X_k) while holding constant the remaining independent variables included in the equation [4].

In the multiple regression model described above, the dependent variable is assumed to be directly related to several independent variables and to adjust simultaneously (in the same time period) with the independent variables. Several of the regression equations derived in the analysis of the Texas transportation bill also include lagged effects of independent variables. In this type of multiple regression model, the value of the dependent variable is related to values of the independent variable in previous years. Expenditures for air passenger transportation, for example, might be explained better by GTP of the previous year than by GTP of the current year. Such lagged relationships between the independent variable and the dependent expenditure variable might be conceived as a planning lag in expenditure reactions.

Another type of regression model with lagged variables was also utilized in this study. In several models, lagged dependent variables are included in the regression equations. In this type of model, the dependent variable (one of the transportation bills) for a given year is related to itself in the previous year. This type of lagged variable regression model is typically called a "dynamic partial adjustment model" or "first-order autoregressive process". An example of this type of model is a truck freight transportation bill estimator that includes the truck freight transportation bill of the previous year as an estimator of the bill for the current year. Such a relationship might be indicative of the effects of multi-period financing arrangements for capital equipment in the trucking industry. Also, lagged dependent variables from other transportation bill equations are included as independent variables in several of the multiple regression equations. As an example, rail freight transportation expenditures for the previous year are used in the estimating equation for the current year expenditures in truck freight transportation. This type of lagged variable model reflects the interdependence of these transportation modes.

Selection of the Best Method

There are three criteria by which the best estimators were selected from among the many possible regression equations formulated to estimate the Texas transportation bill. In order of descending hierarchy they are:

(1) the economic relevance of included dependent variables;

(2) the value of the coefficient of determination; and

(3) the statistical significance of the estimator [4]

The first criterion is imposed in recognition of the many possible independent or explanatory variables that might be included in a regression equation which, in turn, results in a close fit with historical data. That is, a statistically reliable equation for estimating a transportation bill may include such independent variables as the average number of sun-spots in each year, the mean temperature of the oceans in each year, and the real gasoline price index for each year. Although sun-spots and ocean temperatures might be shown as statistically significant, they are spuriously correlated to transportation expenditures. Only the independent variables which have economic significance or theoretical relevance are included in the regression equations in this study.

The second criterion is the value of the coefficient of determination (R^2) derived from each regression equation. High R^2 values imply that most of the variation in the independent variables is explained or determined by variation in the independent variables included in the equation. Conversely, low R^2 values imply that the independent variables have little explanatory power with regard to the estimation of the dependent variable. If the R^2 value is equal to one, the independent variables explain all of the variation in the dependent variable. If, however, the R^2 value is equal to zero, then none of the variation in the dependent variables is included in the equation. Although there is no universally accepted rule for deciding which R^2 value is desirable, the equations selected as estimators of the transportation bill in this study are the equations which yielded R^2 values of at least .80. That is, the independent variables must explain at least 80 percent of the variation in the respective transportation bill.

The third criterion used in this study to select the best regression equation to estimate the individual modal transportation bills is that the estimating equation must be statistically significant. To test for statistical significance, the F-value derived from each regression equation was analyzed. The higher the F-value, the more significant or reliable the estimating equation. Each regression equation included in this study had an F-value large enough to imply at least 95 percent reliability of the estimating equation (statistical) significance at the 5 percent level.

Since many of the equations used in forecasting the Texas transportation bill are first-order autoregressive models, the evaluation of the statistical significance of each independent variable (t-test) is invalid. Therefore, t-tests were not included in the criteria for model selection.

Each regression equation was analyzed with respect to the three criteria mentioned above. In several cases, more than one equation qualified as an estimator of a specific transportation bill. When more than one equation satisfied each of the three conditions, typically the estimator with the highest coefficient of determination was selected as the estimator for the respective transportation mode bill.

In a few cases, none of the equations fulfilled each of the three criteria. When this occurred, alternative means of forecasting were derived from further analysis of the historical data. These alternative means of forecasting the transportation bill were used where, historically, the transportation expenditures in the respective mode did not change significantly over time. It will be shown that the transportation bills of only two modes failed to meet the criteria established for good regression equations.

Reliability of Forecasts

Once the best regression equation has been selected, the reliability of forecasts derived from regression equations can be improved further. There are four factors, besides the selection of the best regression equation, which are determinants of forecast reliability:

(1) the size of the historical data sample,

(2) the dispersion of each independent variable,

(3) the reliability of forecasts of each independent variable, and

(4) the difference between the mean of the historical data and the forecasted data of each independent variable.

As the size of the sample of historical data used in the regression analysis is increased, the reliability of the forecast is improved. Also, if the values of each independent variable are widely distributed, the forecasts derived from a regression equation will tend to be more reliable. The forecast of the dependent variable is improved if the forecasts of the independent or explanatory variables are the best available. Finally, if the forecasted values of the independent variables considered in the regression equation are close to the mean of the historical values of the respective independent variables, the reliability of the forecast of the dependent variable will be high.

This last determinant of forecast reliability is critical in the evaluation of forecasted data. Since several of the forecasted independent variables used in the regression equations tend either to increase or decrease from the historical values of these variables, the reliability of the transportation bill forecasts tends to diminish as the forecast extends into the future. For example, GTP has been shown to increase over the 1959-1975 period, and it has been forecasted to increase over the period 1976-2000. As this independent variable is forecasted into the future, its future values increase and depart further from the mean of the historical GTP values. In this case, the range of "experience" is represented by the historical values of GTP, while the central point of this range is the mean of these historical GTP values. Suppose GTP is an independent variable in a transportation bill regression equation. Inclusion of GTP values outside this range of experience (forecasted values of GTP which increase over time) reduces the reliability of the transportation bill forecast. Subsequently, the farther the forecast of the transportation bill departs from the historical data, the less reliable the forecast of the transportation bill.

This problem of reliability reduction (as the forecast extends through time) is inherent in forecasts of the independent variables as well. The forecasts of these variables might lose reliability if their determinants, in turn, depart significantly from the range of "experience". As a result, the effects which decrease the reliability of forecasts are compounded as the forecast is extended into the future.

The discussion above implies that the reliability of the forecast for each transportation bill might be improved by eliminating from the regression process a critical independent variable which has been forecasted to increase over time. The reliability of the forecasts of the Texas transportation bill was improved by deriving regression equations on a per capita basis. Texas population, which increases over time, does not enter the individual regression equations as an independent variable. It does influence the determination of the total transportation bill, however, which is derived by multiplying the per capita forecast by the forecast of the total state population for each respective year.

Similarly, since prices have tended to increase over time, the reliability of the forecasts derived from the regression equations was improved by regressing only constant dollar independent variables against constant dollar transportation bills. Therefore, both Texas population and the general price index were required variables in the analysis of the Texas transportation bill, even though these variables are not specified in the transportation bill regression equation.

THE INDEPENDENT VARIABLES

In order to be useful in the regression analysis and forecast analysis in this study, independent variables must fulfill two primary requirements. First, each variable must be relevant, in terms of economic theory, to the transportation bill to be analyzed. Second, historical data as well as forecasts of the variable must be available. This second criterion was found to be the most difficult to meet.

There are four independent variables which fulfilled these conditions and were subsequently used in the various regression models in this study:

(1) the GTP per capita,

(2) the real gasoline price index for the U.S.,

(3) the existing Interstate Highway miles in Texas, and

(4) the U.S. unemployment rate.

Annual data and forecasts were collected and analyzed with respect to each of these four variables.

The first independent variable was derived from GTP and population estimates for each year from 1959 to 2000. Estimates of GTP for 1959-1974 were obtained from a University of Texas study of the growth in Texas output [5]. The population estimates for these same years were obtained from U.S. Bureau of the Census data [6].

In recent years, the Texas portion of Gross National Product (GNP) has been approximately the same as the Texas share of the total U.S. population. This result follows from the increase in annual per capita output to approximately the average level of national per capita output. Therefore, the 1975 per capita GTP of $5,632 is about equal to the per capita Gross National Product.

The forecast of GTP used in this study is based on the assumption that the per capita output of Texans will remain approximately the same as the GNP per capita. As a result, forecasts of GTP are the forecasts of GNP allocated to Texas on the basis of the state's share of total national population. Forecasts of GNP for the years 1978-1985 were provided by Data Resources, Incorporated (DRI). The DRI forecasts indicate that GNP will increase at an annual rate of 3.89 percent through 1985 [7].

A first-order autoregressive model was used to forecast GNP for the period 1986-2000. This model is shown below along with the R^2 value of the estimates:

$$GNP_t = 4.2289 + 1.0324\,(GNP_{t-1}),$$

$$R^2 = 99.46,$$

where GNP_t is the GNP of the year forecasted and GNP_{t-1} is the GNP of the previous year.

In this model, the estimates of GNP are determined from estimates of GNP for the previous year. For example, using this equation results in a GNP forecast for 1986 greater than the 1985 forecast of GNP by 3.24 percent of the 1985 forecast plus 4.2289 billion dollars. This forecast technique results in a slightly slower average annual GNP growth rate than that predicted by DRI through 1985. Such a predicted slowing of aggregate economic growth is acceptable since it is indicative of a maturing national economy.

As mentioned above, the forecast of GTP was derived by allocating a portion of GNP to Texas on the basis of the state's share of the total U.S. population. The U.S. population forecasts utilized in this study are published projections made by the U.S. Bureau of the Census while the Texas populations are published projections by researchers at the University of Texas [8]. These state forecasts were adjusted to the 1977 U.S. Bureau of the Census estimates of Texas population. The forecasts as well as the estimates of Texas population from 1959 through 1977 are shown in Figure 1.

The forecasts of Texas population and U.S. population indicate that the state's share of national population will increase from 5.7 percent in 1975 to about 6.2 percent in 1985. By 2000, this share will be approximately 7.4 percent of the forecasted total U.S. population. These forecasts show that over the entire forecast period from 1975-2000, the Texas share of U.S. population will continually increase.

Two factors, therefore, influence the growth in forecasted GTP: (1) the sustained growth in forecasted GNP, and (2) the sustained growth in Texas' share of forecasted U.S. population. These two factors result in a forecasted average annual increase in GTP from 1975-2000 of 4.65 percent compared to an average annual increase in GTP between 1959-1975 of 4.47 percent. The estimates and forecasts of GTP shown in Figure 2 indicate the projected increase in the growth of Texas output.

Per capita GTP is also forecasted to increase faster than the growth in per capita GTP between 1960-1975. For example, for 1960-1975, per capita GTP increased approximately 33 percent; while over the fifteen years from 1975 through 1990, GTP is forecasted to increase by about 35 percent. This projected increase in per capita GTP growth is due partially to the recent trends in women's increasing participation in the labor force as well as the recent trend toward smaller families. The trend to smaller families implies that the ratio of income earners to non-income earning dependents in Texas will increase. This in turn may contribute to increases in the per capita output of Texas.

Many of the transportation bill regression equations include the real gasoline price index for the U.S. as an independent variable as well as per capita GTP. This gasoline price index is used as a measure of the real gasoline

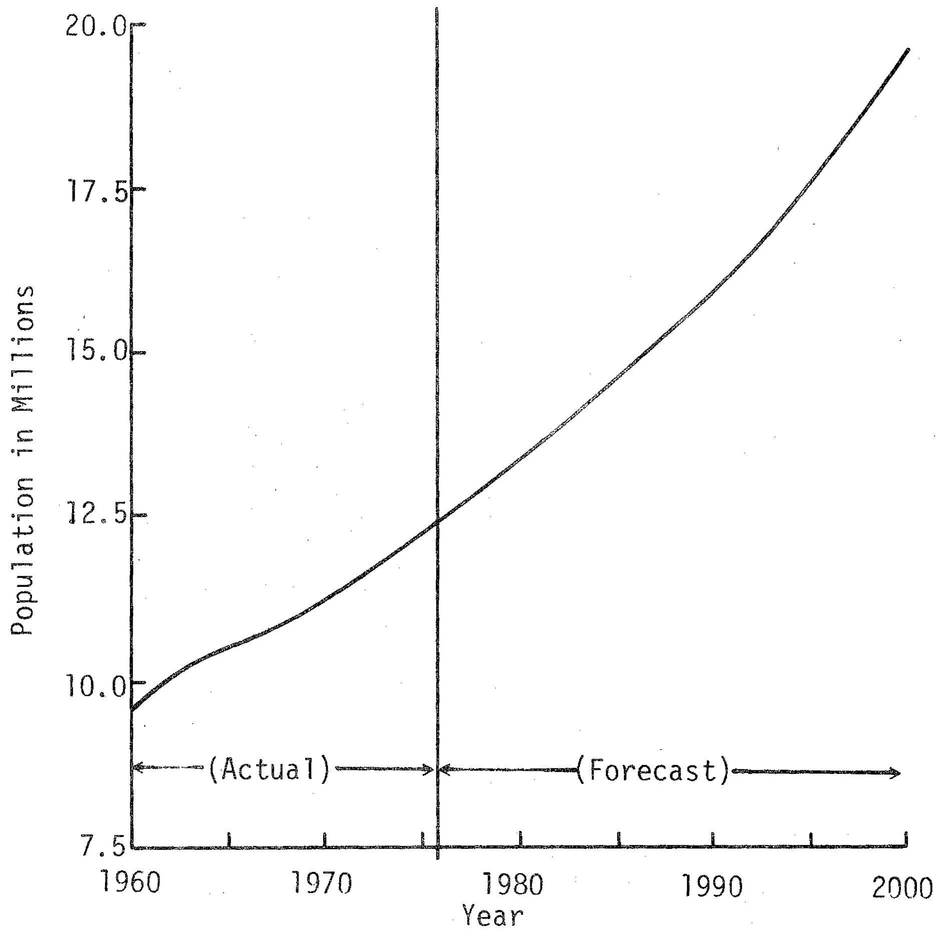

Figure 1. Texas Population
(In Millions)

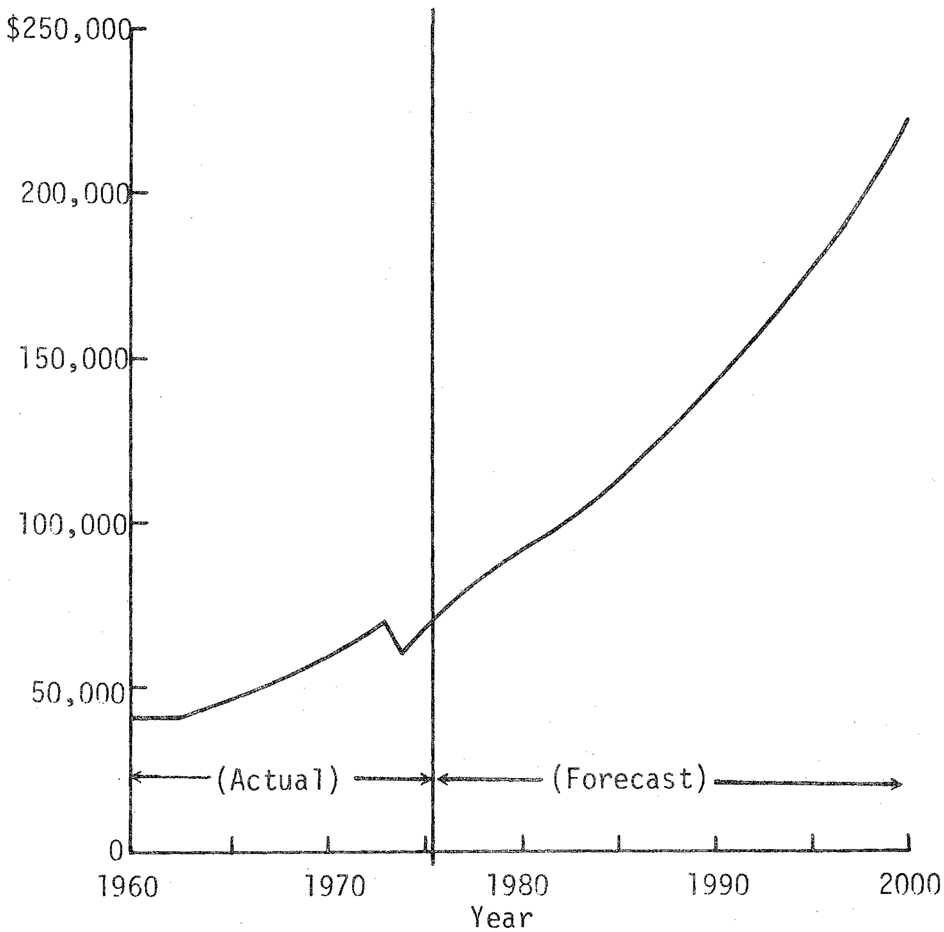

Figure 2. Gross Texas Product
(In Millions of 1972 Dollars)

prices in the state, as well as a measure of the shadow prices for other petroleum products. As a result, it was discovered to be significant in several of the regression equations for transportation modes which do not require gasoline, such as air passenger transportation and railroad freight transportation. It may be viewed as a variable which reflects the cost of energy to each transportation mode.

The real gasoline price index for the years 1959-1977 was derived from price indices published by the Bureau of Labor Statistics [9]. Annual values for the real gasoline price index were obtained by dividing the U.S. city average price index for gasoline by the Consumer Price Index (CPI) for the respective years [9]. The resulting gasoline price index shows gasoline prices in real or deflated terms. Since 1972 was the year in which the lowest gasoline prices occured over the nineteen years of data, it serves as the base year for the real gasoline price index.

The forecast of the real gasoline price index, for the most part, was derived in the same fashion as the estimates of the gasoline price index for the period 1959-1977. In this case, the index from 1978 through 1986 was obtained from forecasts of the U.S. city average price index for gasoline and forecasts of the CPI derived by Chase Econometrics, Inc [10]. The real gasoline price index declines over the entire range of these forecasted years.

Since the 1986 forecasted real gasoline price index is approximately equal to the average of the real gasoline price indices for 1959-1977, the forecasts of the indices from 1987 through 2000 are assumed to remain at the 1986 level. The real gasoline price indices for the period 1960-2000 are shown in Figure 3. The assumed lower limit on the forecasted real gasoline price index is consistent with the effects expected from the depletion of petroleum reserves and the increase in energy demands expected during the latter part of this century.

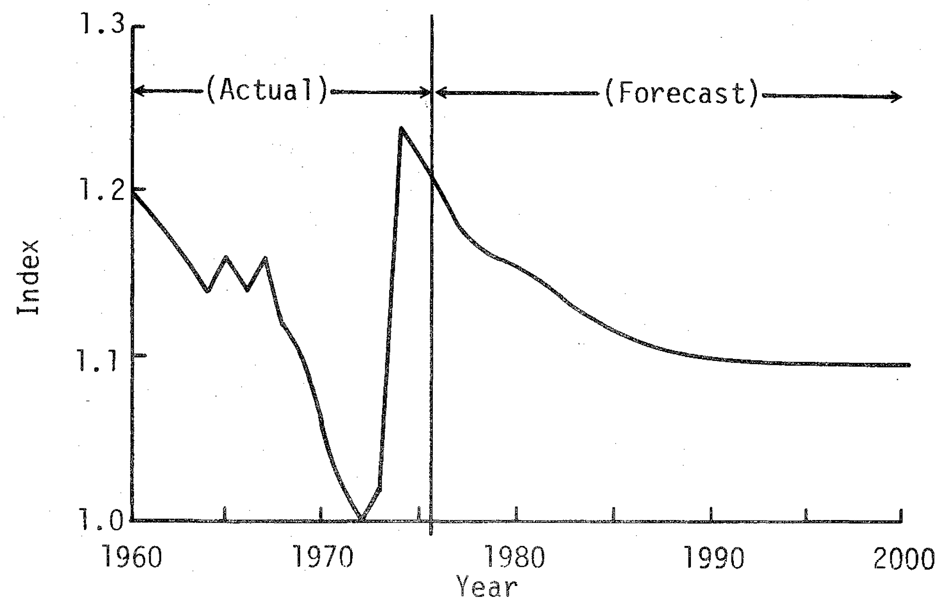

Figure 3 . Real Gasoline Price Index
(1972=100)

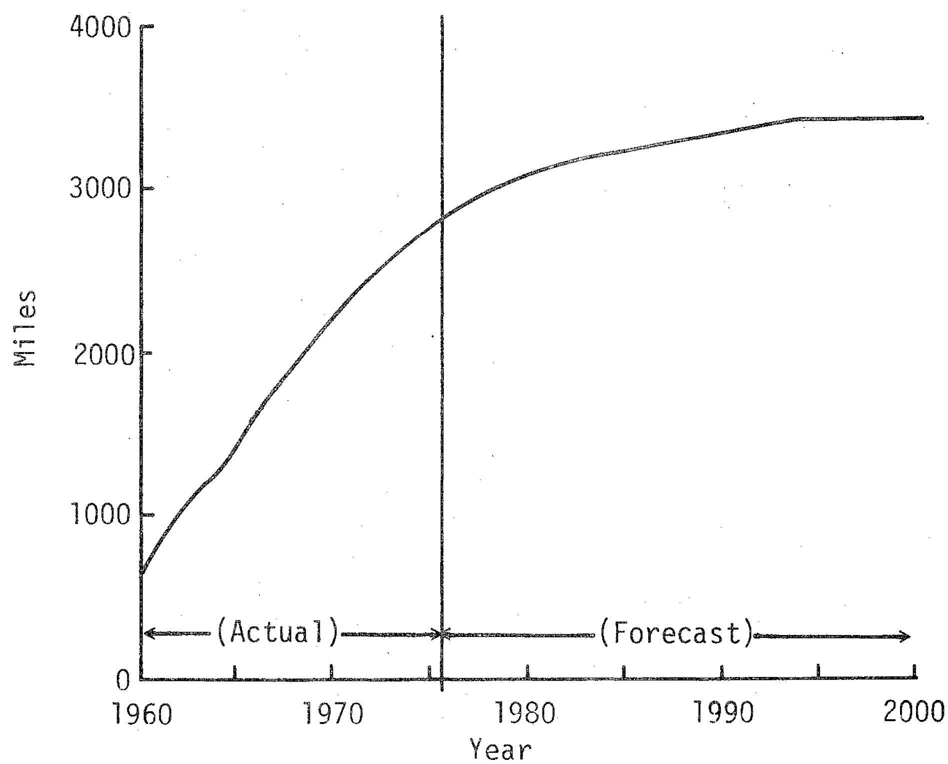

Figure 4. Texas Interstate Highway Miles

The third independent variable mentioned above is the existing miles of interstate highways in Texas. Annual estimates and forecasts of interstate miles in Texas were obtained from data supplied by the Texas State Department of Highways and Public Transportation [11]. Figure 4 shows that the rapid increase in the growth of interstate highway miles (apparent during the years prior to 1975) decreases in the forecasted years. By 1990, most of the proposed Texas interstate highway system will be completed.

Interstate highway miles are used as an independent variable in several of the individual transportation bill regression equations to account for the influence that the transportation system has on transportation expenditures. In this sense, the regression equations which include interstate highway miles might also be found to be a significant influence in non-highway transportation regression equations. This is due to the crucial support role that trucking and auto transportation have with respect to other modes such as water and air transportation.

The fourth independent variable mentioned above is the annual U.S. unemployment rate [12]. This variable reflects the general level of economic activity in the nation. The effects of business cycles are readily observed by analyzing unemployment data. Several of the regression equations in this study include the unemployment rate as a significant explanatory variable. As a result, expenditures in these transportation modes are expected to be relatively sensitive to fluctuations in the level of general economic activity.

Ideally, the Texas unemployment rate should be used as an indicator of economic activity in the state. However, the historical observations of the Texas unemployment rate are not complete, and forecasts of future Texas unemployment rates are not available. Therefore, the unemployment rates included in the regression analysis are national unemployment rates.

Forecasted national unemployment rates from 1977 through 1980 are from the U.S. Office of Management and Budget [13]. Since the annual non-wartine U.S. unemployment rates tend to average about 5.0 percent, the U.S. unemployment rate for 1981-2000 is assumed to be at the 5.0 percent level. Historical and forecasted estimates of the annual U.S. unemployment rates used in this study are shown in Figure 5. This figure shows that the forecasted U.S. unemployment rate is expected to decrease to 5.0 percent from a peak of 7.7 percent in 1975.

In the following section, each of the models used to derive forecasts of the Texas transportation bill by transportation mode is discussed. The importance of the four independent variables in these regression equations will be emphasized in that discussion.

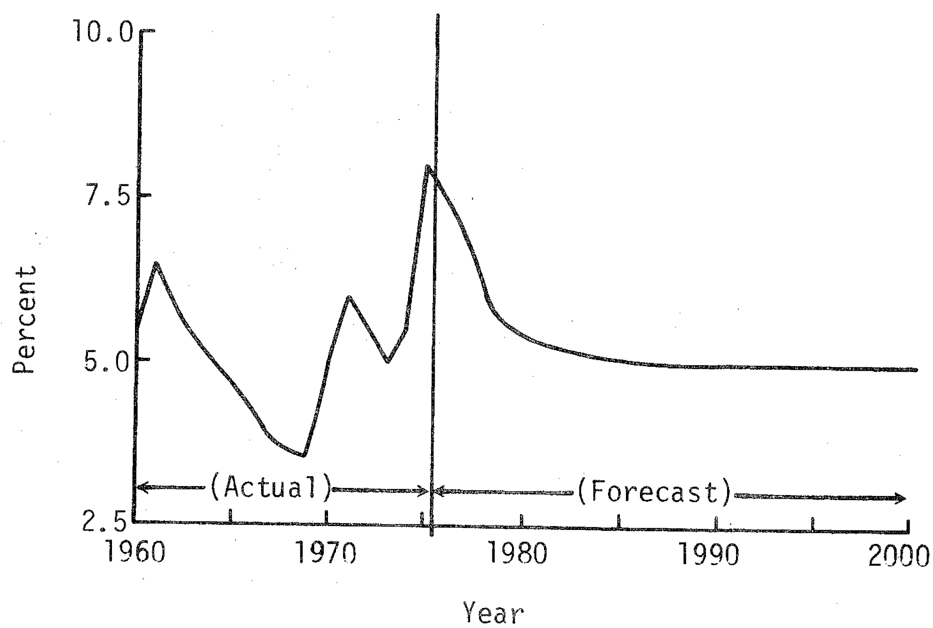

Figure 5. U.S. Unemployment Rate

THE ESTIMATORS OF THE TEXAS TRANSPORTATION BILL

The estimators used to derive the forecasts of the Texas transportation bill are presented in this section. Most of these estimators are equations derived from regression analysis. However, as mentioned previously, when the regression technique generated unreliable estimators (as noted by low R^2 values or low F-values), alternative estimation techniques were utilized. Each estimator is discussed whether it is the result of regression techniques or other estimation procedures. The forecasts derived from each of these estimators are discussed in a later section.

The analysis of each of these estimators is presented with regard to (1) reliability, and (2) specification. Thus, the transportation expenditure estimator for each transportation mode is followed by an analysis of the sign as well as the size of the coefficients of the relevant variables. First, the estimators of transportation expenditures of each passenger transportation mode are analyzed and discussed. Later, each of the freight transportation bill estimators is similarly discussed.

PASSENGER TRANSPORTATION BILL ESTIMATORS

As shown in the transportation bills presented in Tables 1 and 2, there are six components of the Texas passenger transportation bill. Automobile transportation and general aviation components of the bill comprise the private modes of passenger transportation. Estimators for these two private passenger transportation modes are presented below and followed by estimators for the for-hire modes of passenger transportation.

Estimator for the Per Capita Auto Transportation Bill

The best per capita estimator of expenditures in auto transportation includes three independent variables. This estimator is the result of regressing all three of these variables against the per capita automobile transportation bill from 1959 through 1975. It is expressed as:

$$Y = -367.3881 + .6780\,X_1 + .0662\,X_2 + 207.6872\,X_3$$

where X_1 is the total auto bill per capita in the preceding year, X_2 is constant dollar GTP per capita, and X_3 is the real gasoline price index in the previous year.

An indication of the explanatory power of the estimator is shown by the R^2 value of .9157 which implies that 91.57 percent of the variation in per capita auto transportation expenditures is explained by variation in the independent variables X_1 through X_3. The reliability of the estimator is relatively high as shown by a multiple regression F-value of 43.45. This F-value shows the estimator to be statistically significant at the 95 percent confidence level.

The lagged auto transportation bill coefficient implies that the auto transportation bill of the current year is partially determined by 67.8 percent of the auto transportation bill of the previous year. This lagged effect takes into consideration the multi-period financing of automobiles.

The per capita GTP coefficient implies that GTP per capita in the current year is positively related to auto transportation expenditures. If the other independent variables (X_1 and X_3) are held constant, the increase in auto transportation per capita in Texas amounts to approximately 6.6 percent of the increase in per capita GTP. Therefore, the forecasted trend of increasing per capita

GTP (as described earlier), will contribute to the future growth of the per capita auto transportation expenditures in Texas.

Constant dollar prices of gasoline also influence private automobile transportation expenditures in Texas. If the other independent variables (X_1 and X_2) are held constant, the regression coefficient for the gasoline price index parameter suggests that a one percent increase in the real price index of gasoline will result in approximately a 2.08 dollar increase in per capita auto transportation expenditures in the state. Thus, gasoline prices are important in determining private auto transportation expenditures in the state.

Estimator for the Per Capita General Aviation Transportation Bill

The best estimator for the general aviation bill per capita consists of a regression equation which includes two independent or explanatory variables. This equation is shown below as:

$$Y = -7.2179 + .4536\ X_1 + .0026\ X_2$$

where X_1 is the per capita expenditures in general aviation in the preceding year, and X_2 is the constant dollar GTP per capita in the current year.

Regression analysis produced an R^2 value of .971 for the general aviation estimator shown above, meaning that 97.1 percent of the variation in the dependent variable is explained by the lagged general aviation bill per capita and the GTP per capita of the current year. The reliability of the estimator is relatively high as indicated by the resulting F-value of 217.48 for the equation. So, the general aviation regression equation is a statistically significant estimator at the 95 percent confidence level.

As in the case of the regression equation for the auto bill, the general aviation bill is partially determined by a lagged dependent variable. The lagged general aviation transportation bill coefficient implies that the current year general aviation expenditures per capita are determined, at least in part, by approximately 45.4 percent of the general aviation expenditures of the previous year. The remainder of the per capita general aviation bill for the current year is largely determined by per capita GTP of the current year.

Bus, Taxi, and Transit Transportation Bill Per Capita Estimator

Bus, taxi, and transit transportation expenditures in Texas were regressed against several independent variables and discovered to be explained primarily by three independent variables. The regression equation is specified as

$$Y = 6.1730 + .7717\ X_1 - .0037\ X_2 - .2856\ X_3$$

where X_1 is the total of bus, taxi, and transit expenditures per capita in Texas for the previous year; X_2 is the automobile passenger transportation expenditure per capita for the previous year; and X_3 is the U.S. unemployment rate for the current year.

The multiple regression R^2 value is 93.38, which implies that approximately 93 percent of the variation in the bus, taxi, and transit bill per capita is explained by the three independent variables. The calculated F-value for the regression equation is 56.46, which shows that the equation is a statistically significant estimator of the per capita bus, taxi, and transit bill at the 95 percent level of confidence.

The positive coefficient for the lagged bus, taxi, and transit bill shows that past usage and past expenditures of this transportation mode influences the current year usage and expenditures in bus, taxi, and transit travel. For example, bus ridership might be associated with people who have few alternative means of transportation. In other words, this regression equation implies that an abrupt jump to private auto transportation for these riders will typically not occur. Also, this coefficient supports the proposition that taxi services which do not have readily available alternatives are the crucial transportation mode for non-local intracity travellers.

A negative sign appears with respect to the lagged automobile expenditure coefficient. This suggests that increases in total automobile travel expenditures result in decreases in bus, taxi, and transit expenditures. Such a result is possibly due to the potential substitution of private automobile transportation for bus, taxi, and transit transportation. Thus, if Texans increase their annual expenditures for auto travel, they tend to decrease their expenditures for forms of mass transit transportation.

Increases in the national unemployment rate also have a negative influence on the bus, taxi, and transit expenditures by Texans. This relationship, as shown by the negative sign of the X_3 coefficient, might be due to a decline in intracity travel expenditures as people become unemployed. The apparent sensitivity of bus, taxi, and transit expenditures to the unemployment rate was not shown to occur in the auto transportation bill model shown above. Thus, unemployment and its attendant implications with respect to the business cycle, have smaller influences on auto transportation expenditures than on mass transit and taxi transportation expenditures in Texas.

School Bus Transportation Bill
Per Capita Estimator

The School bus bill estimator obtained by regression analysis takes the form:

$$Y = -2.8056 + .9595 X_1 + .0002 X_2 + 1.7875 X_3$$

where X_1 is the school bus transportation expenditure per capita for the previous year; X_2 is the GTP per capita for the previous year; and X_3 is the constant or real dollar gasoline price index for the current year.

The R^2 coefficient derived for this estimator is .889, so that about 89 percent of the variation in the school bus transportation bill is statistically determined by variation in the independent variables. Statistical significance at the 95 percent confidence level is indicated by an F-value of 32.16 for the school bus bill regression equation shown above.

The coefficient for the lagged school bus transportation bill per capita (X_1) shows that about 96 percent of the school bus transportation expenditures for the previous year determine a portion of the bill for the current year. This result might be a reflection of the influence of local tax revenues which typically rise within income increases. These tax revenues are used, in turn, to finance local school bus operations.

Gasoline prices are also shown to influence the expenditures for school bus transportation. This is shown by the gasoline price index coefficient, which implies that a one cent increase in the constant dollar price of gasoline results in about a 1.79 cent increase in per capita expenditures for busing school children. School bus expenditures, therefore, are not as sensitive to changes in the price of gasoline as are expenditures for auto transportation for the same price index variable.

Rail Passenger Transportation Bill
Per Capita Estimator

The best estimator for rail passenger transportation is a first-order autoregressive model with one explanatory variable. This relatively simple equation is specified as:

$$Y = .0436 + .9246\ X$$

where X is the rail passenger bill per capita of the preceding year.

For this equation, the R^2 value is 97.84; thus, about 98 percent of the variation in the rail passenger bill per capita is explained by the variation in the rail passenger bill per capita of the previous year. This model is shown to be a highly reliable predictor of the rail passenger bill as suggested by the F-value of 634.43. As with each of the previous estimators, this shows the equation is a statistically significant estimator of per capita rail passenger expenditures.

The lagged rail passenger bill coefficient is positive which means that the rail bill per capita for the current year is approximately 92.5 percent of the rail bill per capita of the previous year. Forecasts of the rail passenger bill per capita are, therefore, limited to unidirectional movement. The restriction to only downward movement in forecast data is clearly not a desirable characteristic in an estimator. However, the rail passenger estimator alone is a highly descriptive as well as reliable estimator of past trends in rail passenger transportation. Although short-run policy changes by supporters of rail passenger travel may stem the inexorable downward trend of annual decreases in rail passenger expenditures by Texans, the downward trend is historically apparent and expected to continue on the basis of historical information.

Air Passenger Transportation Bill Per Capita Estimator

Expenditures by Texans for commercial air passenger transportation were regressed against the independent variables. As a result, the best estimator derived is shown below:

$$Y = -51.6490 + .0140\ X_1 + 21.8701\ X_2$$

where X_1 is the per capita GTP of the previous year; and X_2 is the index of real gasoline prices for the current year.

Almost 95 percent of the variation in air passenger transportation expenditures were found to be explained by the equation alone. This is shown by the derived R^2 value .950 for the estimator. A large measure of reliability is conveyed with regard to the estimating power of this equation by a relatively high F-value of 122.73.

The positive per capita GTP coefficient suggests that as output (or similarly as income) per capita increases annually, there is a propensity for per capita expenditures in air travel to increase in the following year. This lag between income realization and air transportation expenditures by people travelling by air might be due to trip planning habits. As income of people increases in one year, business trips and vacation trips by air seemingly occur the following year.

Additionally, increases in real income per capita also increase the relative time cost of travel by transportation modes which are time intensive. For example, as income increases, a businessman in Texas might decide to fly from Dallas to Houston rather than drive. By flying, the businessman might save several hours of time which could be productively spent in business negotiations. Also, people may tend to value leisure time higher as income increases. Higher incomes imply they might wish to fly to vacation locations rather than spend vacation time on the highways.

A positive coefficient with respect to the real gasoline price index represents two effects. First, as gasoline prices increase, travellers tend to switch from auto passenger travel to air passenger travel. Second, as real gasoline prices increase, the price of aviation fuels usually increases as well. This cost increase might, in turn, be eventually translated into increases in air passenger fares. With relatively constant or increasing use of air passenger service, this fare increase will result in increased expenditures in air passenger travel.

FREIGHT TRANSPORTATION BILL ESTIMATES

An estimator for each of the freight transportation components of the Texas freight transportation bill is presented in this section. It is shown that regression analysis fails to provide a reliable estimator for two of these components. Analysis of the historical data from 1959 through 1975, however, reveals that an alternative means of forecasting the future transportation expenditures in these two modes is available.

The first three estimators shown are the regression equations which comprise the highway portion of the freight transportation bill. This analysis is followed by a presentation of the non-highway components of the bill.

Truck-Intercity Freight Bill Per Capita Estimator

A conceptualization of the determinants of expenditures in Texas for the movement of goods between cities is provided by the intercity truck bill estimator. In this estimator, the intercity truck freight transportation bill is linked with expenditures in another crucial freight transportation mode. The per capita intercity truck estimator is specified as:

$$Y = 137.4270 + 1.1153\, X_1 + .0210\, X_2 - 74.2683\, X_3$$

where X_1 is the per capita railroad freight transportation bill for the previous year; X_2 is per capita GTP for the current year; and X_3 is the real gasoline price index for the previous year.

The coefficient of multiple regression for this equation is .8457 which suggests that most of the per capita intercity truck transportation bill is explained by the independent variables included in the equation. The estimator is significant at the 95 percent confidence level as shown by the derived F-value of 21.93.

The positive coefficient of the lagged railroad freight transportation bill variable implies that as railroad freight expenditures increase in a given year, intercity truck expenditures will increase the following year. This one year lag in intercity truck transportation might derive from the time lag between transporting bulk primary inputs to producers by rail and transporting finished products by truck to various markets.

Intercity truck transportation expenditures were also found to be influenced by GTP. If GTP per capita increases, the intercity truck freight bill also increases, as shown by the positive sign of the GTP coefficient in the equation.

Lagged real gasoline prices affect the expenditures for the intercity transportation by truck. The negative sign of the lagged real gasoline price index implies that an increase in real gasoline prices in the previous year will tend to decrease the intercity truck transportation bill in the current year. This negative effect might be the result of the influence which increases in operating costs have on the expenditures in truck transportation. If fuel prices increase, shippers might switch over time to alternative less fuel intensive freight transportation means. Additionally, the one year lag apparent from the above equation might be the result of the lag between the realization of higher fuel costs by truck owners and the response in higher freight rates by regulatory commissions (i.e., the I.C.C.).

TRUCK-LOCAL FREIGHT TRANSPORTATION BILL PER CAPITA ESTIMATOR

The local trucking bill per capita is largely explained by two independent variables. The derived regression equation is specified as:

$$Y = 82.1842 + 1.0198 X_1 - 65.5846 X_2$$

where X_1 is the local truck transportation bill per capita for the previous year; and X_2 is the real gasoline price index for the current year.

An R^2 value for this equation of .9112 indicates that most of the variation in the local trucking transportation bill is explained by the variation in X_1 and X_2. The F-value of the equation is 66.68, which means that this equation is a reliable and statistically significant estimator of the local trucking bill.

A positive sign for the lagged local trucking coefficient indicates that the estimated trucking bill increases annually by approximately 1.98 percent if gasoline prices remain constant in real dollars. This estimate of continuous growth follows from the increased urbanization of Texas as well as the dependence which these urban economies place on truck transportation for intracity commerce.

Gasoline prices in constant dollars are shown to have a negative influence on local freight transportation expenditures. For example, the negative sign of the coefficient of the real gasoline price index suggests that an increase in the real price of gasoline will result in a decrease in the per capita expenditures for local truck transportation. This negative reaction to gasoline prices stems from the influence that increases in gasoline prices, and hence, increases in the cost of local trucking exert on expenditures by shippers.

Bus Freight Transportation Bill Per Capita Estimator

The transportation bill for goods shipped by bus is explained by the four independent variables in the following equation:

$$Y = .1746 + .5191\ X_1 - .0030\ X_2 + .0001\ X_3 - .0091\ X_4$$

where X_1 is the bus freight bill per capita for the previous year; X_2 is the rail freight bill per capita for the previous year; X_3 is GTP per capita for the current year; and X_4 is the U.S. unemployment rate for the previous year.

These independent variables explain almost all of the variation in the bus freight bill. This is shown by the relatively high R^2 value of .988 derived with respect to this equation. The bus freight equation is also statistically significant at the 95 percent confidence level as suggested by the F-value of 231.22.

A lagged bus freight coefficient of .5191 implies that over half of the bus freight bill for the previous year determines a portion of the bus freight bill. Additionally, bus freight transportation is shown to be negatively related to rail freight transportation expenditures for the previous year. This might be due to the substitution of bus freight for rail freight, specifically for the goods that require special handling or routing.

Expenditures by Texans for bus freight transportation are also influenced by the level of per capita GTP. As per capita GTP increases, Texans spend more for bus freight transportation. This might be due to the relative advantage that bus freight transportation has over most trucking operations with regard to the speed of intercity delivery of non-bulk items. Therefore, when Texans wish to ship small quantities of items rapidly in Texas, bus freight might be the preferred transportation mode.

Since bus freight transportation largely involves the movement of small sized but high valued items between cities, general business conditions might influence the movement of goods by bus in Texas. This effect is shown by the negative sign of the unemployment coefficient in the estimator. As U.S. unemployment increases, while all other independent variables remain constant, the bus freight transportation bill tends to decrease.

RAIL FREIGHT TRANSPORTATION BILL PER CAPITA ESTIMATOR

The best regression equation for the estimation of per capita expenditures for rail freight transportation includes two explanatory variables and is expressed as:

$$Y = 64.0755 + .6573 X_1 - 37.8054 X_2$$

where X_1 is the per capita rail freight transportation bill for the previous year; and X_2 is the gasoline price index for the previous year.

Most of the variation in the dependent variable in this equation is explained by variation in the included independent variables. This explanatory power is expressed by an R^2 value of .875 for the regression equation. Further, the estimator is statistically significant at the 95 percent level of confidence with an F-value of 45.42.

Per capita railroad freight expenditures in the previous year exert a direct influence on the per capita rail freight bill in the current year. The estimator suggests that if real gasoline prices do not change, the rail freight transportation bill is equal to approximately 65.7 percent of the bill of the previous year plus $64.08 per capita. The real gasoline price index, on the other hand, has an inverse relationship with a specific portion of rail freight expenditures.

The positive relationship between the shipments by rail in the previous year and shipments by rail in the current year might be due to the effects that the long-term capital costs and union contracts in the railroad industry have with respect to the stabilization of freight rates. Additionally, commodities that are typically shipped in bulk cargo lots over railways do not have readily available transportation alternatives. Therefore, grain and many other commodities shipped in bulk traditionally travel long distances by rail.

The negative sign of the lagged real gasoline price index variable implies that railroad freight transportation expenditures are affected by the influence of fuel prices. This is the result of several effects. First, railroad freight transportation usually requires other more fuel intensive transportation modes (typically local and intercity trucking) to provide additional handling and routing services for shippers who use rail transportation. As a result, railroad freight transportation is not impervious to the effects of fuel prices as shown by the estimator for rail transportation expenditures. Fuel or gasoline prices do affect rail freight expenditures; however, the negative coefficient of the gasoline price index variable is smaller for rails than the gasoline price index coefficient in either of the trucking estimators. This implies that the absolute effect of changes in fuel prices is greater with regard to the truck transportation bills than with the rail transportation bills.

Fuel prices affect rail transportation expenditures in another way. If the change in the real price of gasoline or fuel occurred, the quantities of these petroleum products sold as well as the quantities of related products might change. That is, if gasoline prices increase in real terms, the quantity of gasoline sold might decline, and in turn, the quantity of gasoline as well as crude oil shipped by rail to buyers might decline. Since many petroleum and petroleum related products are shipped by rail as well as truck, the market price influence on the quantities of petroleum products sold may affect expenditures in these transportation modes.

WATER FREIGHT TRANSPORTATION BILL PER CAPITA ESTIMATOR

Regression analysis of water freight transportation expenditures failed to result in a reliable estimator of the water transportation bill. Analysis of the historical data from 1959 through 1975 reveals that the per capita expenditures in constant dollars for water transportation do not vary significantly. No significant increasing or decreasing trend in these per capita expenditures is shown to occur. Therefore, the average per capita expenditure in constant dollars for water transportation for the years from 1959 through 1975 of 42.29 dollars is assumed to be the estimate for future per capita expenditures in freight transportation by water in Texas. This implies that if GTP per capita increases in the forecasted years, water freight transportation expenditures will decline as a share of GTP.

This does not mean that the total expenditures in water transportation will remain constant. Total expenditures in Texas for water transportation will increase due to the increase in the state's population. Also, the assumption of constant per capita expenditures does not imply that a constant amount of cargo per capita is shipped by water. Increased economies realized from the technological advances in transporting and handling waterborn cargoes have been historically realized. Larger and more efficient ships as well as containerization of cargoes have resulted in reduced shipping costs per ton of cargo. Additionally, water carrier shipping rates may have decreased in real terms. For example, the use of foreign flag carriers by shippers from Texas ports might result in lower rates than the use of American flag waterborne carriers. Substitution of cheaper foreign carriers for American carriers applies, however, only to ocean-going waterborne freight. The Jones Act requires that intracoastal waterborne freight must be shipped by U. S. carriers [14].

Oil Pipeline Transportation Bill Per Capita Estimator

Regression analysis also failed to yield a reliable estimator of oil pipeline transportation expenditures. As with the water freight transportation bill, per capita expenditures for transportation by oil pipelines have not shown either a statistically significant increasing or decreasing trend over the seventeen years of historical data. Therefore, the average constant dollars per capita pipeline bill from 1959 through 1975 is used as the estimator of future per capita expenditures for this transportation mode. This average is 43.76 dollars.

Technological improvements as well as government regulation of pipeline transportation have contributed to the relatively constant per capita expenditures apparent in pipeline transportation. For example, larger diameter pipes result in economies of pipeline transportation. Further, recent developments in computerized handling of the crude oil and refined products transported by pipeline have reduced the costs of pipeline operation. These reduced costs, in turn, affect the rates charged by pipeline carriers. Also, pipeline rates are subject to either regulation by the Interstate Commerce Commission (ICC) or regulation by the Railroad Commission of Texas. Such rate regulation might serve to hold down pipeline transportation rates. Each of these factors influence the rates pipelines charge to shippers which, in turn, affects the per capita pipeline transportation expenditures in the state.

AIR FREIGHT TRANSPORTATION BILL PER CAPITA ESTIMATOR

Expenditures in Texas for the transportation of freight by commercial air carriers were used to derive a regression equation for the air freight transportation mode. This estimator is specified as:

$$Y = 2.4332 + .0114 X_1 - 3.1193 X_2 + .0010 X_3$$

where X_1 is the intercity truck transportation bill for the previous year; X_2 is the real gasoline price index for the current year; and X_3 is the total miles of interstate highways in Texas in the current year.

This regression equation explains most of the variation in the dependent variable as suggested by a .934 R^2 value. Additionally, the estimator is significant at the 95 percent confidence level. The reliability of the estimator is indicated by a F-value of 56.54.

Lagged intercity truck transportation expenditures have a direct effect on the estimates of air freight transportation expenditures derived with the regression equation. The positive sign on the lagged intercity trucking variable suggests that truck transportation is complementary to air freight transportation.

The negative sign of the gasoline price index coefficient implies that air freight transportation expenditures tend to decrease as real gasoline prices increase, if all the other independent variables are held constant. Since the real price of gasoline can be considered a shadow price for other petroleum products, the negative sign of the gasoline price index reflects the effect of increased aviation fuel prices on air freight expenditures. The negative relationship between fuel prices and air transportation expenditures does not appear in the air passenger transportation bill.

Interstate highways are shown to benefit air cargo carriers. A positive coefficient for the interstate highway miles variable shows this relationship. More interstate highways in Texas create better and more efficient distribution channels for air freight cargoes. As a result, the delivery speed gained by the use of air delivery service is enhanced by the interstate highway system. This relationship has general implications with regard to the entire highway system in Texas and air freight transportation. Better roads seem to enhance air freight service.

Other Freight Transportation Bill Per Capita Estimator

Freight transportation services, such as freight handlers and freight forwarders, are included in the "other freight transportation" category. The estimator for expenditures for their service is specified as:

$$Y = 46.7767 + .0456\ X_1\ - .0079\ X_2\ - 1.9642\ X_3$$

where X_1 is the local trucking transportation bill per capita for the previous year; X_2 is the per capita GTP for the previous year; and X_3 is the U.S. unemployment rate for the previous year.

The R^2 value for this estimator is .949, so that most of the variation in this freight transportation bill category is explained by the variables included in the regression equation. Further, the equation is revealed to be a statistically significant estimator of this bill since the F-value is a relatively high 74.77.

Expenditures for the service of freight forwarders and freight handlers are shown by the regression equation to be positively related to expenditures in local trucking. This positive relationship is intuitively plausible. However, over the years from 1959 through 1975, expenditures for these freight forwarding and handling services in Texas decreased. The negative coefficient of the lagged GTP variable reflects this expenditure decrease. Most of the decrease in these expenditures is due to the inclusion of freight forwarding and freight handling services as a part of the services provided by firms which provide the transportation. Therefore, trucking companies themselves currently tend to provide these services; and, as a result, the expenditures for freight forwarding and handling are included in the truck transportation bill. The growth in per capita GTP in Texas was accompanied by a decrease in expenditures in the "other transportation bill" category.

The expenditures for other transportation services are also influenced by the general level of economic activity in Texas. As unemployment increases, these expenditures tend to decrease. The relationship is shown by the negative coefficient of the U.S. unemployment rate variable included in the estimator shown above.

THE TRANSPORTATION BILL FORECAST

The estimators presented in the previous section were used to derive annual forecasts of the per capita transportation bill by mode. These per capita forecasts were then each multiplied by the annual forecasts of Texas population to obtain the total forecasted expenditures for transportation in Texas. In this section, analyses of the per capita and the total transportation bill forecasts are presented.

Before presenting the per capita transportation bill forecasts, it is worth repeating that these are forecasts of private sector expenditures, including transportation user taxes paid by the private sector. Thus, government expenditures for transportation, in a sense, are included to the extent that they are figured from taxes paid by the transportation sector. However, it should be understood that this inclusion is only in this very indirect way. Also, since non-user taxes (i.e., general tax revenues) are used to subsidize some modes, such as rail passenger, bus passenger, and water freight, the overall expenditure on these modes may be underestimated using the private sector viewpoint.

Total expenditures for some transportation modes thus differ from the forecasted private sector expenditures due to government expenditures or subsidies. If, for example, the forecasted bill for a specific transportation mode decreases to zero at some future date, this does not imply that this transportation mode will cease to exist. Such a forecast implies that expenditures by the private sector will no longer be made for this transportation mode. Service may continue to be provided, however, in this transportation mode through public funds provided by government agencies. The zero forecasted private sector expenditures suggest that the entire sector would virtually cease to exist in the absence of either subsidies from the public sector or enforced subsidies from other parts of the private sector (e.g., rail freight subsidizing rail passenger, as probably was the case in the past).

This private sector approach to forecasting the Texas transportation bill is taken to elucidate the long run trends of transportation expenditures in the state when the direct effects of changes in the policy of government expenditures for transportation are excluded. The forecast essentially represents what private sector expenditures for transportation in Texas will be if the policy of government with respect to future transportation expenditures is the same as the government policy with respect to past transportation expenditures.

In the first of the following three major sections, the analysis of the per capita transportation bill forecasts is presented. This analysis indicates the relative importance of the various transportation modes in Texas. Additionally, the per capita analysis will be useful in demonstrating future trends in Texas transportation expenditures. In the next section an analysis of the total transportation bill forecast is given. This analysis indicates the magnitude of transportation expenditures by transportation mode. Further, the total transportation bill forecast can be compared to forecasted GTP to show the trends of the transportation expenditures and total state output. In the final section the forecast analysis will be summarized.

Per Capita Forecasts of the Texas Transportation Bill

Per capita forecasts derived from the estimators discussed earlier are helpful in revealing how much each means of transportation contributes to the long-run trend of the total transportation bill. The modal per capita forecasts also have an appeal for less analytical purposes, for they indicate approximately how much each person (on the average) in Texas will spend for transportation.

Whereas decreasing forecasted unemployment and real gasoline prices as well as increasing forecasted per capita GTP provide a relatively good forecasted economic climate for transportation in Texas, it will be shown that several transportation modes are not expected to fare as well as other transportation modes. In other words, if past trends in transportation are expected to continue, several modes will not be viable transportation alternatives.

The per capita analysis begins with a methodological examination of the modal distribution of the forecasted per capita passenger bill. This is followed by an analysis of the modal distribution of forecasted per capita freight transportation expenditures in Texas.

PER CAPITA PASSENGER TRANSPORTATION BILL FORECAST

Although forecasts of the per capita transportation bill do not reveal the magnitude of total expenditures in transportation, they do show the distribution of transportation expenditures among the various modes. Per capita estimates and forecasts of the passenger bill were used to derive the distribution of passenger transportation expenditures for selected years shown in Tables 4 and 5.

Table 4
Distribution of the Texas Passenger Transportation Dollar

	1965	1975	1985	1995
Auto	88.9¢	89.6¢	90.5¢	90.6¢
General Aviation	1.2	1.6	1.8	1.9
Bus, Taxi, and Transit	2.6	1.4	.2	0
School Bus	.5	.6	.9	1.0
Rail Passenger	.2	.1	0	0
Air Passenger	6.6	6.7	6.5	6.5
TOTAL	100.0¢	100.0¢	100.0¢	100.0¢

Table 4 shows that out of each dollar spent in Texas for passenger travel, 88.9 cents were spent (on the average) for private automobile transportation in 1965. In 1995, however, out of each passenger transportation dollar, auto travelers in Texas will spend approximately 90.6 cents (on the average).

The per capita auto transportation bill forecast indicates that the growth in private auto travel expenditures will increase and then slow over the forecasted years. For example, the per capita auto bill expenditures in 1965 were 470.56 in 1972 dollars (see Table 5). By 1975, these expenditures grew approximately 42 percent above the 1965 level. The forecast shows that by 1985, however, the per capita expenditure will grow almost 65 percent above the 1975 level. The forecasted increase in growth might be the result of greater per capita expenditures for automobiles themselves, since this time series trend is implicit in the GTP variable of the auto transportation estimator. Additionally, over the 1975-1985 forecast period, real gasoline prices are forecasted to decline. Such a decrease in gasoline price should stimulate growth in automobile transportation expenditures. From 1985 through 1995, the per capita auto bill forecast grows only 28 percent above the 1985 level. This eventual slowing in the growth of auto travel expenditures is largely due to the forecasted stabilization of real gasoline prices (after 1986) to the level that existed before the Arab oil embargo.

Table 5
Per Capita Passenger Transportation Expenditures
(In 1972 Dollars)

	1965	1975	1985	1995
Auto	$470.56	$668.71	$1,104.02	$1,523.09
General Aviation	6.16	11.71	21.72	31.63
Bus, Taxi and Transit	13.77	10.59	5.24	0
School Bus	2.86	4.41	9.58	16.33
Rail Passenger	1.18	.27	0	0
Air Passenger	34.80	50.14	78.95	108.73
TOTAL	$529.33	$745.83	$1,219.51	$1,679.78

General aviation expenditures in Texas are also forecasted to increase over the forecasted years as shown in Table 4 and 5. Out of each dollar spent in Texas for general aviation in 1965 approximately 1.2 cents were spent for noncommercial air passenger service. By 1975, general aviation amounted to 1.6 cents per passenger dollar. This represents a 90.2 percent growth rate in per capita general aviation expenditures over the ten years prior to 1975. By 1985, however, the forecasted share of the passenger dollar spent for general aviation will rise to 1.8 cents. This is a growth of 85.5 percent above the 1975 per capita expenditures for general aviation in Texas. Over the 1985-1995 period, the general aviation bill in Texas is forecasted to grow approximately 45.6 percent above the 1985 level. The slower growth in general aviation in the decade beyond 1985 is attributable to the slower growth of GTP over the same years.

Table 4 also reveals that the bus, taxi, and transit expenditures in Texas are forecasted to decrease from 1.4 cents of the passenger dollar in 1985. This decrease in the bus, taxi, and transit share of the Texas passenger dollar reflects an approximately 50.5 percent decrease in per capita bus, taxi, and transit expenditures. The forecasted per capita expenditures decrease to zero by 1995 (see Table 5). Decreasing per capita expenditures in this category over the 1975-1995 period are the continuation of a 1968-1975 historical trend. The historical trend of decreasing per capita expenditures for bus, taxi, and transit travel in Texas contributes to the decreasing relative share of the passenger transportation dollar for the 1965-1975 period shown in Table 4. This expected decline of bus, taxi, and transit transportation in Texas by 1994 is the result of the negative statistical relationship between expenditures in this category and expenditures for private auto transportation.

This forecast indicates that the long run trend of passenger transportation in Texas is biased against bus, taxi, and transit services. Additionally, the forecast implies that almost the entire cost of the operation of mass transportation it services in Texas cities must be paid by public funds if these passenger services are to continue after 1994.

Per capita expenditures for school bus transportation in Texas, on the other hand, are forecasted to increase over the 1975-2000 period. Whereas, .5 cents and .6 cents of the respective 1965 and 1975 passenger dollar were spent for school bus transportation, the 1985 school bus expenditures amount to approximately .9 cents of the passenger dollar. By 1995, about one cent of each dollar spent for passenger transportation in Texas will be spent for school bus transportation. This upward trend of school bus transportation's share of the passenger dollar is a continuation of the trend of increasing per capita expenditures in this passenger transportation category since 1973. The forecasted increase in the school bus transportation share of the passenger transportation dollar is largely the result of increases in forecasted GTP per capita which implies that as incomes in Texas increase, the tax revenues for school bus transportation will also increase.

The rail passenger expenditure share of the Texas passenger dollar, shown in Table 4, decreased over the 1965-1975 period. The forecast of per capita rail passenger expenditures indicates that by 1980 rail passenger service in Texas will cease. This forecast implies that unless the historical trend of decreasing expenditures for rail passenger service is altered by policy changes, the future of passenger travel by rail in Texas is in serious doubt. Also, this forecast implies that almost the entire cost of rail passenger service operation must be augmented by subsidies from public funds if rail passenger service is to survive after 1980.

The air passenger share of the Texas passenger transportation dollar is shown in Table 4 to decrease slightly and remain relatively constant. Approximately 6.6 cents and 6.7 cents of the Texas passenger dollar were spent in 1965 and 1975, respectively, for commercial air passenger transportation. This reflects an increase in per capita expenditures for air passenger service of 44.1 percent (see Table 5). Although the air passenger portion of the Texas transportation dollar is forecasted to decrease to 6.5 cents in 1985, per capita expenditures are forecasted to increase by 57.5 percent between 1975 and 1985, and by 47.7 percent between 1985 and 1995.

The forecasted decrease in the growth rate of commercial air passenger expenditures in Texas between 1985 and 1995 is the result of relatively constant real gasoline prices as well as showing growth in per capita GTP over these years. Per capita air passenger expenditures, like expenditures for private auto transportation, are forecasted to grow over the 1975-1985 period faster than growth in the same category over the 1965-1975 period. The growth of the air passenger bill then slows over the 1985-1995 period below the growth rate over the 1965-1975 period. The expected growth patterns of per capita air passenger expenditures and per capita auto expenditures are similar because the independent variables included in the respective estimators as well as the signs of the coefficients in each of the respective estimators are identical. The trend of decreasing growth in per capita air passenger expenditures over the 1985-1995 forecast period follows from the slowing growth in per capita GTP along with relatively constant forecasted real gasoline prices.

The analysis of the Texas passenger transportation dollar suggests that in the future more will be spent out of the passenger dollar for private auto, general aviation, and school bus transportation, while less will be spent for alternative passenger modes. Per capita private sector expenditures on bus, taxi, transit, and rail passenger are forecasted to decrease in absolute as well as relative magnitudes. It is important to emphasize two points with respect to these forecasts for bus, taxi, and transit. First, the forecasts are made using historical trends and thus do not take into account the effects of the large government subsidies of recent years, which are anticipated to continue at least in the immediate future. Second, the bus, taxi, and transit are forecasted as a group and individual modes may experience growth or decline that is different from the group as a whole. Air passenger service expenditures are forecasted to remain about the same in relative importance, while increasing in absolute per capita amounts. It is important to recognize that the air passenger forecast, like the others, is for expenditures, not passenger miles, which could conceivably increase even in relative importance even if expenditures decrease in relative importance.

PER CAPITA FREIGHT BILL FORECASTS

An analysis of the per capita passenger bill forecast reveals future trends in the relative expenditures for passenger transportation in Texas. In this section a similar analysis of the per capita freight bill forecast is presented. It is shown that specific trends in freight transportation expenditures in Texas are also apparent.

The per capita forecasts derived from the Texas freight bill estimators are used to determine the future distribution of the freight transportation dollar as shown in Table 6. This table presents the portion of the freight transportation dollar (on the average) spent on various transportation modes in the state.

Table 6
Distribution of the Texas Freight Transportation Dollar

	1965	1975	1985	1995
Highway	69.9¢	76.1¢	82.2¢	86.1¢
Rail	10.9	9.3	6.8	5.6
Water	7.8	6.7	4.7	3.7
Pipe Line	8.0	5.8	4.9	3.8
Air	.5	.6	.6	.5
Other	2.9	1.5	.8	.3
	100.0¢	100.0¢	100.0¢	100.0¢

Highway freight is shown to be the largest component of the entire freight transportation bill in each of the years included in the table. It grew from 69.9 cents of the freight bill dollar in 1965 to 76.1 cents of the freight transportation bill expenditures per dollar in 1975. This growth reflects an increase in per capita expenditures for highway freight of 39.1 percent over the 1965-1975 period as shown in Table 7. The 1975-1985 forecasted distribution shows that highway freight transportation expenditure will increase from 76.1 cents to 82.2 cents of the Texas freight transportation dollar. This seemingly large increase in the highway share of the freight bill dollar represents a 35.3 percent increase in per capita expenditures over the same years (see Table 7). Therefore, the growth rate of per capita expenditures for highway freight transportation is expected to decrease. The 1985 to 1995 growth of per capita highway freight expenditures will increase by 34.4 percent of the 1985 per capita highway freight bill. Although per capita growth in highway freight is expected to decrease slightly, the highway share of the freight transportation dollar in Texas (on the average) will increase as shown in Table 6.

Table 7
Per Capita Freight Transportation Expenditures
(In 1972 Dollars)

	1965	1975	1985	1995
Highway	$392.94	$546.45	$739.50	$ 994.01
Rail	61.34	66.81	61.62	64.61
Water	43.68	48.19	42.49	42.49
Pipe Line	44.70	41.35	43.76	43.76
Air	3.05	4.47	5.50	6.24
Other	16.43	11.13	7.15	3.16
TOTAL	$562.14	$718.40	$900.02	$1,154.27

The local trucking per capita components of the per capita highway freight bill will grow more rapidly than the intercity trucking component of the highway freight bill. Local trucking per capita expenditures grew at a rate of 67.4 percent over the 1965-1975 period, while they are forecasted to grow at 44.8 percent and 44.5 percent over the 1975-1985 and 1985-1995 periods respectively. Intercity trucking expenditures per capita, on the other hand, increased 13.3 percent between 1965 and 1975 and are forecasted to grow 22.5 percent over the 1975-1985 period. The rate of increase then falls to 18.4 percent for the 1985-1995 period. The forecasted change in the growth rate of per capita intercity trucking expenditures are most likely due to its direct relationship with per capita GTP.

The rail freight portion of the Texas freight transportation dollar is shown in Table 6 to decrease over the included range of years. Whereas in 1965 almost 10.9 cents of every freight dollar was spent for rail transportation, by 1975 the railroads share of the freight dollar decreased to 9.3 cents. This decrease in relative share of the freight dollar is forecasted to continue. By 1985 the railroads' share of the freight dollar is expected to be 6.8 cents, and by 1995 the share will decrease further to 5.6 cents.

Although the rail freight portion of the total freight transportation dollar decreased over the 1965-1975 period, real per capita expenditures for rail freight increased approximately 8.9 percent over the same period. Since the railroad freight bill estimator is negatively related to lagged real gasoline prices, falling real gasoline prices (until 1973) produced a slight increase in per capita rail freight expenditures. Subsequently, the lagged effects of gasoline price increases are expected to contribute to a fall in per capita rail freight expenditures to approximately 7.8 percent of their 1975 level. By 1995, however, the expected decrease in real gasoline prices will result in an increase in per capita rail freight expenditures to 4.8 percent of the 1985 level, as shown in Table 7.

Table 6 shows that water freight and oil pipeline transportation each tend to decrease as a share of the Texas freight transportation dollar. Although these modes are shown to decline in relative share of freight expenditures in Texas, real per capita expenditures in each have historically tended to remain relatively constant. This consistency in per capita expenditures for these modes is expected to continue over the entire forecast period (see Table 7).

The air freight portion of the Texas freight transportation dollar is expected to remain relatively constant over the forecast period. Out of each freight transportation dollar, approximately one-half cent was spent for air freight in Texas in 1965 and 1975 as well. While the air freight share of the Texas freight transportation dollar is expected to remain constant, per capita expenditures are expected to grow at a decreasing rate. For example, during the 1965-1975 period, per capita air freight expenditures grew at about 46.5 percent of the 1965 level (see Table 7). By 1985, however, air freight expenditures in Texas are forecasted to grow by approximately 23 percent of the 1975 level. Over the decade from 1985 through 1995, real per capita air freight expenditures are forecasted to grow by only 13.4 percent of the 1985 level. This slow growth in air freight is due primarily to the effects of: (1) decreasing and then relatively constant real gasoline price; (2) increasing and then relatively constant interstate highway miles in Texas.

Other freight service expenditures per capita are expected to decrease over the entire range of forecasted years. This result follows from the historical trend of local and intercity trucking, air freight, and rail freight firms including freight forwarding and freight handling activities in their own freight transportation services. The trend is shown in Table 5. In 1965, 2.9 cents of the Texas freight transportation dollar went toward other freight services. By 1975 only 1.5 cents of the Texas freight transportation dollar was spent for other freight services such as forwarding and handling. In 1985, other freight services are expected to account only for .8 cents of each Texas freight dollar, and by 1995 this portion is forecasted to decrease further to about .3 cents.

In summary, the per capita forecasts of the Texas freight transportation bill indicate that highway freight transportation will obtain a larger share of the Texas freight transportation dollar. Additionally, per capita expenditures for highway freight shipments are expected to increase at a decreasing rate. Conversely, non-highway freight transportation modes will obtain a smaller share of the Texas freight transportation dollar. Real per capita expenditures for these non-highway freight modes are generally forecasted to decrease over the 1975-1985 period and remain relatively constant thereafter.

The per capita forecast of the Texas transportation bill also shows that per capita expenditures for passenger transportation will exceed the per capita expenditures for freight transportation. For example, in 1965 the passenger bill per capita was approximately 48.5 percent of the per capita total transportation bill. By 1975, the passenger bill component was 50.9 percent of the per capita total transportation bill. The forecast reveals that by 1985 the per capita passenger transportation bill comprises almost 57.5 percent of the total per capita transportation expenditures in Texas. In 1995, approximately 59.3 percent of the per capita transportation bill is expected to be spent on passenger travel. This trend of increasing passenger expenditures per capita follows from the trend toward larger residential dispersion as well as increased leisure time which can be spent for travel.

These per capita forecasts of passenger and freight transportation expenditures do not reveal the entire role of transportation in the future economy of Texas. The effects of population changes are not included in

Table 8

TEXAS PASSENGER BILL FORECAST
(In Millions of 1972 Dollars)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000
Private Transportation																	
Total Auto	$ 9,127.1	$ 9,946.4	$10,714.1	$11,431.2	$12,202.1	$12,962.6	$13,679.2	$ 14,455.5	$ 15,250.0	$ 16,028.1	$ 16,836.0	$ 17,672.4	$ 18,574.1	$ 19,539.3	$ 20,569.9	$ 26,705.5	$ 34,772.7
General Aviation	157.2	174.2	191.7	208.6	224.8	243.0	260.9	277.4	296.3	315.4	333.6	352.9	373.4	395.1	418.2	554.6	734.7
Total Private Transport	9,284.3	10,120.6	10,905.8	11,639.8	12,426.9	13,205.6	13,940.1	14,732.9	15,546.3	16,343.5	17,169.6	18,025.3	18,947.5	19,934.4	20,988.1	27,260.1	35,507.4
For-Hire Transportation																	
Bus, Taxi and Transit	120.9	113.3	108.9	105.4	101.8	98.2	93.5	88.2	82.4	76.0	69.3	62.3	55.0	47.2	38.8	0	0
School Bus	60.7	67.6	74.9	82.7	90.9	99.6	108.7	118.3	128.4	139.1	150.1	161.8	174.2	187.5	201.6	286.2	399.6
Rail	2.5	1.8	1.2	.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Air	665.0	723.9	775.1	825.3	871.2	928.3	981.1	1,027.8	1,089.4	1,146.2	1,197.4	1,260.0	1,326.1	1,395.9	1,469.9	1,906.5	2,478.2
Total For-Hire Transportation	849.1	906.6	960.1	1,013.9	1,063.9	1,126.1	1,183.3	1,234.3	1,300.2	1,361.3	1,416.8	1,484.1	1,555.3	1,630.6	1,710.3	2,192.7	2,877.8
Grand Total - Private and For-Hire	$10,133.4	$11,027.2	$11,865.9	$12,653.7	$13,490.8	$14,331.7	$15,123.4	$ 15,967.2	$ 16,846.5	$ 17,704.8	$ 18,586.4	$ 19,509.4	$ 20,502.8	$ 21,565.0	$ 22,698.4	$ 29,452.8	$ 38,385.2
Gross Texas Product	$74,126.5	$78,350.7	$82,292.2	$86,068.1	$90,719.4	$94.951.0	$98,769.4	$103,699.9	$108,299.1	$112,574.9	117,465.9	122,616.3	128,053.6	133,787.5	139,857.7	175,355.2	221,054.1
Grand Total as % of GTP	13.7	14.1	14.4	14.7	14.9	15.1	15.3	15.4	15.6	15.7	15.8	15.9	16.0	16.1	16.2	16.8	17.4

the analysis to present a complete picture of the relationship between transportation and future economic activity in the state.

Forecast of the Total Texas Transportation Bill

The annual per capita forecasts discussed in the previous section were multiplied by population projections to yield the forecast of the Texas transportation bill. Tables 8 and 9 present the constant dollar forecast in a form similar to the historical freight and passenger bill estimates in Tables 1 and 2. Table 8 includes the annual passenger bill forecasts from 1976 through 1990 as well as the passenger bill forecast for 1995 and 2000. Table 9 includes the annual freight bill forecasts for these same years. The total forecasted passenger bill for the state is shown by the grand total of private and for-hire expenditures in Table 8. The total forecasted freight bill for Texas is shown by the grand total row in Table 9.

Forecasted constant dollar GTP for each year is given in both tables along with the respective total passenger bill or total freight bill percent of GTP. As with the estimates presented in Tables 1 and 2, these percentages are given in order to indicate the relative magnitude of the respective bills and total economic activity in the state.

First, an analysis of the total passenger expenditures in Texas over the forecast period is presented. This analysis will emphasize the changes in magnitude of the forecasted Texas passenger bill. Second, an analysis of the forecasted Texas freight bill is given to indicate the trends in total freight transportation expenditures in Texas over the 1976-2000 period. Next, the modal shares of the forecasted passenger and freight bill are each analyzed. These shares are shown as the percent that expenditures for

Table 9

TEXAS FREIGHT BILL FORECAST
(In Millions of 1972 Dollars)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000
Highway																	
Truck-Intercity	$ 3,083.8	$ 3,148.6	$ 3,234.4	$ 3,336.6	$ 3,459.6	$ 3,583.6	$ 3,708.1	$ 3,856.1	$ 3,998.0	$ 4,136.8	$ 4,290.6	$ 4,454.6	$ 4,617.9	$ 4,784.3	$ 4,956.1	$ 5,916.3	$ 7,102.7
Truck-Local	4,048.7	4,253.9	4,480.5	4,719.8	4,978.7	5,260.5	5,561.0	5,881.0	6,223.4	6,589.4	6,982.5	7,395.2	7,828.6	8,283.4	8,761.4	11,497.1	14,904.0
Bus	4.8	5.4	6.1	6.8	7.4	8.0	8.5	9.0	9.4	9.9	10.3	10.7	11.2	11.6	12.2	15.4	19.8
Total Highway	7,137.3	7,407.9	7,721.0	8,063.2	8,445.7	8,852.1	9,277.6	9,746.1	10,230.8	10,736.1	11,283.4	11,860.5	12,457.7	13,079.3	13,729.7	17,428.8	22,026.5
Railroads	777.6	760.1	758.8	769.1	781.6	799.3	822.1	845.3	869.0	894.6	921.3	950.5	976.4	1,000.4	1,023.3	1,132.8	1,247.4
Water	567.1	539.6	548.1	556.9	566.1	575.5	585.3	595.5	606.0	616.9	628.1	639.8	651.8	664.2	677.0	745.0	819.8
Oil Pipe Line	547.3	555.7	564.5	573.6	583.0	592.7	602.8	613.3	624.1	635.3	646.9	658.9	671.3	684.0	697.3	767.3	844.3
Air	54.2	57.9	60.4	62.9	65.4	68.3	71.0	73.7	76.8	79.8	83.0	85.9	89.0	91.7	94.4	109.3	127.1
Other Shipper Costs	134.2	131.2	128.2	125.0	121.7	118.4	114.9	111.3	107.6	103.7	99.8	95.6	91.8	86.8	82.1	55.5	22.6
Grand Total	$ 9,217.7	$ 9,452.4	$ 9,781.0	$10,150.7	$10,563.5	$11,006.3	$11,473.7	$ 11,985.2	$ 12,514.3	$ 13,066.4	$ 13,662.5	$ 14,291.2	$ 14,937.5	$ 15,606.4	$ 16,303.8	$ 20,238.7	$ 25,087.7
Gross Texas Product	$74,126.5	$78,350.7	$82,292.2	$86,068.1	$90,719.4	$94,951.0	$98,769.4	$103,699.9	$108,299.1	$112,574.9	$117,465.0	$122,616.3	$128,053.6	$133,787.5	$139,857.7	$175,355.2	$221,054.1
Grand Total as % of GTP	12.4	12.1	11.9	11.8	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.7	11.7	11.7	11.7	11.5	11.3

each transportation mode represent of either the total freight or the total passenger transportation bill. Finally, the forecasted transportation bill is compared with forecasted GTP to emphasize the relationship between future output in Texas and future transportation expenditures in the state. As with the per capita analysis, the size and importance of expenditures for transportation modes are emphasized in this section.

TOTAL PASSENGER BILL FORECAST

The total passenger bill, as shown in Table 8, increases over the entire forecasted time series from the 1976 level. This forecast indicates that by 1986 the total Texas passenger transportation bill will be double the 1975 bill in constant dollars. The forecast also suggests that the passenger bill will double again in approximately 14 years after 1986. This slower rate of growth over the 1986-2000 period is approximately the same as the passenger bill growth rate prior to 1975. The forecast of the Texas passenger transportation bill, therefore, implies that over the next decade annual passenger transportation expenditures will increase at a relatively rapid rate.

A large measure of this forecasted increase in passenger transportation bill growth over the 1976-1986 period is the result of the private passenger component of the bill. Within the private passenger category, both automobile and general aviation expenditures are forecasted to increase at about 5 to 6 percent annually over the 1976-1986 period. Most of the growth in these two modes is the result of forecasted increases in GTP and Texas population. Both of the variables have a positive influence on the size of automobile and general aviation expenditures in Texas. Over the years from 1986 through 2000, growth in these two modes is reduced somewhat due to the expected slowing of growth in both GTP and Texas population.

In the for-hire categories, school bus transportation expenditures are forecasted to increase over the entire range of forecasted years. Although school bus transportation expenditures are expected to grow over the forecast period, the growth rate decreases from almost 12.5 percent from 1975 to 1976 to 6.8 percent from 1999 to 2000. This slowing growth trend coincides with the forecasted slowing growth in both GTP and Texas population. The growth in air passenger expenditures in Texas is forecasted to decrease slightly from 8.4 percent annually in 1976 to 4.5 percent annually in 1986. By 2000, however, the annual growth rate of the air passenger transportation bill in Texas increases to about 5.4 percent in constant dollars.

Several components of the for-hire passenger transportation category, however, are not expected to grow in constant dollars over the forecast period. For example, rail passenger expenditures are forecasted to decrease from the 1975 level. By 1980, private sector expenditures for rail passenger travel as shown in Table 8 will be negligible. Expenditures for bus, taxi, and transit travel are also forecasted to decrease in the future. The forecasted trend in Table 8 indicates that expenditures for this portion of the for-hire passenger transportation bill will be negligible by 1995.

Although expenditures in two of the for-hire passenger transportation modes are expected to decrease, the expenditures for the for-hire passenger transportation category are expected to increase at an average annual rate of approximately 5 percent over the 1976-2000 period.

Total Freight Bill Forecast

The average annual growth of the total freight bill is forecasted to be approximately the same from 1975 through 2000 as the average annual growth over the 1959-1975 period. Each year, on the average, the Texas freight transportation bill is expected to increase annually by about 4.3 percent in constant dollars. This annual rate of increase is generally smaller than the average forecasted passenger transportation bill annual rate of growth of approximately 5.9 percent. Since total passenger expenditures in Texas were above total freight expenditures in the state in 1975, this implies that Texas' freight bill is forecasted to be less than the Texas passenger bill over the 1975-2000 period (see Figure 6). Prior to 1970 the total expenditures for freight transportation were generally greater than the total expenditures for passenger transportation. Therefore, the Texas transportation bill forecast implies that as Texas population and output grows, expenditures for transportation in the state will be more passenger transportation intensive.

Highway freight transportation is the largest component of the state's total freight transportation expenditures. In 1960 and 1975, highway freight transportation expenditures were 65.4 percent and 76.1 percent, respectively, of the total freight transportation bill. This trend of increasing importance of highway freight transportation relative to other freight transportation modes is expected to continue throughout the forecasted years. For example, in 1985, 1995, and 2000 the highway freight transportation expenditures are forecasted to comprise 82.2 percent, 86.1 percent, and 87.8 percent, respectively, of the total freight transportation bill.

Before 1971, intercity trucking was the largest component of the highway freight transportation expenditures in Texas. Since 1971, however, local

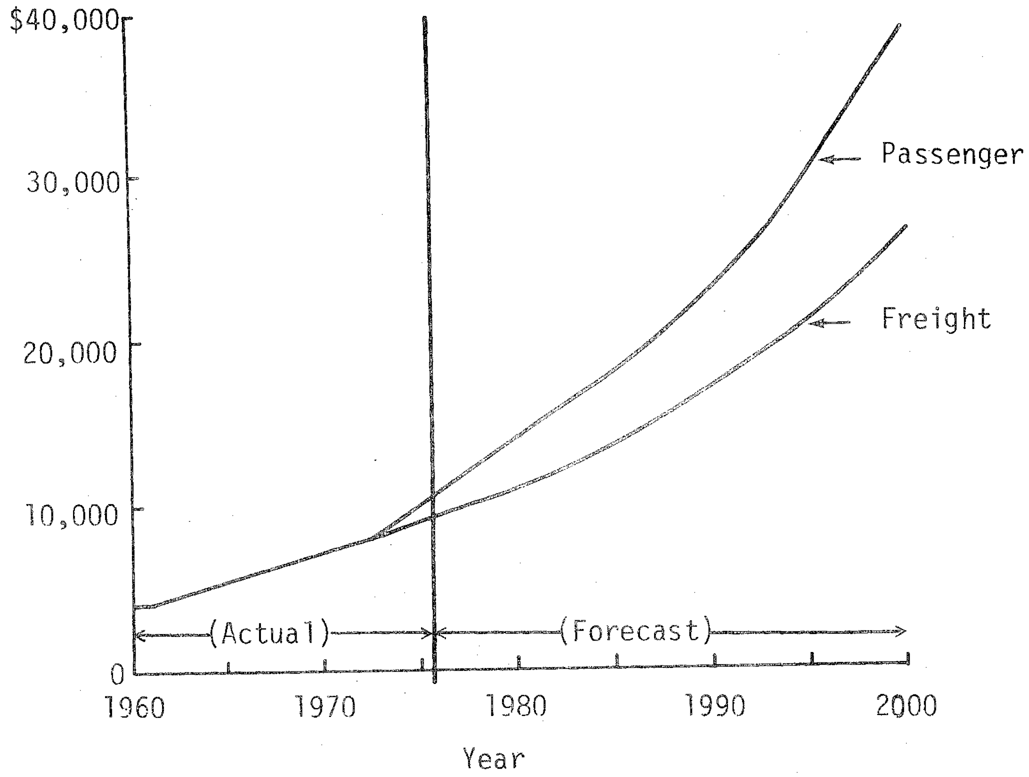

Figure 6. Components of the Total Transportation Bill (In Millions of 1972 Dollars)

trucking transportation expenditures have exceeded the intercity trucking transportation bill. This trend is most likely the result of increased urbanization in Texas along with increased operating efficiencies of intercity truck transportation. Such cost reducing factors as interstate highways, diesel power plants, and larger trucks might have reduced the ton-mile operating costs of intercity trucking relative to the ton-mile cost of local truck operation. These influences on cost may, in turn, affect the relative expenditures for intercity truck and local truck freight transportation.

Intercity trucking is forecasted to have a smaller role in highway freight expenditures than local trucking. For example, in 1975, intercity trucking expenditures in Texas accounted for approximately 42.6 percent of total highway freight movement expenditures. By 1985, intercity trucking will account for about 38.5 percent of the total highway freight bill. This percentage is forecasted to decrease still further, until by 2000 only 32.2 percent of total highway freight expenditures in Texas will be attributed to intercity trucking operations. Table 9 shows that intercity trucking transportation expenditures in Texas by 2000 will be less than half of local trucking transportation expenditures in the state. Over the 25 years forecasted, intercity trucking is projected to grow approximately 2.5 times the 1975 level.

Intercity trucking, on the other hand, is forecasted to grow about 3.9 times the 1975 level by the year 2000. In 1975, local trucking accounted for 57.4 percent of total highway freight transportation expenditures. By 1985, local trucking expenditures are forecasted to increase to 61.4 percent of the total highway freight bill. The local trucking share of the total highway freight bill is forecast to continue increasing until the year 2000, when 67.7 percent of the total highway freight bill will be composed of local trucking transportation expenditures.

Although bus freight expenditures were about .0007 percent of the highway freight bill in 1975, Table 9 indicates that the bus freight bill is expected to increase over the forecasted period. By 2000, the forecast shows that the bus freight bill will be about 4.5 times the size of the 1975 bus freight bill.

Total highway freight transportation expenditures are shown in Table 9 to grow over the entire forecast period. In 1975, highway freight transportation was approximately 76.1 percent of the total freight bill. The forecast shows that by 2000, highway freight expenditures will be about 87.8 percent of the total freight bill. This indicates that highway freight transportation will have an increasingly crucial role in future economic activity in Texas.

Since the highway freight transportation modes are forecasted to comprise a larger portion of the state's annual freight bill in the future, the non-highway freight transportation modes, conversely, are expected to compose a smaller share of the future Texas freight bill. Although the non-highway freight transportation modes are forecasted to have a smaller share of the total freight bill, the forecasts in Table 9 indicate that expenditures for most of these non-highway modes will increase in constant dollars over the forecast period.

Railroad freight expenditures are the largest component of the non-highway freight bill. Table 9 shows that rail freight expenditures in Texas will increase in the long run. However, over the 1976-1978 period, annual rail freight expenditures in constant dollars are forecasted to decrease. This decrease follows from the effects of relatively high forecasted real price of petroleum fuels in the early 1980's. As mentioned previously in the discussion of the rail freight bill estimator, the high fuel prices might retard railway freight expenditures either by increasing the cost of complementary modes of freight transportation, say local trucking, or by decreasing the volume of petroleum and petroleum related products carried by rail.

The forecast indicates that rail freight transportation expenditures in Texas increase after 1978 (see Table 9). By 1982, the rail freight bill exceeds its 1975 level; and by 1985, the rail freight bill is about 9.5 percent greater than the 1975 rail freight bill. Table 9 indicates that this increasing trend continues until 2000. By this time, the rail freight bill will have grown by almost 60 percent of the 1975 rail freight transportation expenditures. Whereas in 1975, the rail freight bill was approximately 39 percent of the total non-highway freight bill, by 2000, rail freight transportation represents about 41 percent of the total non-highway freight bill.

Water freight transportation expenditures as well as oil pipeline transportation expenditures in Texas are shown in Table 9 to increase over most of the forecasted years. In 1975, the water freight bill and the oil pipeline bill were 29 percent and 24 percent, respectively, of the total non-highway freight bill. By 1985, the water freight bill is forecasted to decrease to about 26 percent of the total non-highway bill while the oil pipeline bill increases its share to approximately 27 percent of the total non-highway freight bill. The forecast indicates that by 2000 each of these components of the total non-highway freight bill will increase by about one percent. This suggests that both the water freight and the oil pipeline transportation expenditures will each remain a relatively constant portion of non-highway freight transportation expenditures in Texas.

The freight bill in constant dollars for commercial air service are shown in Table 9 to increase over the forecasted years. In 1975, air freight expenditures were about 2.6 percent of the total non-highway freight bill. The forecast shows that by 1985, air freight expenditures in Texas increase to approximately 3.4 percent of the total non-highway freight bill. Air freight transportation expenditures are forecasted to increase to about 4.2 percent of the total non-highway freight bill by 2000. This increase in the forecasted air freight share of the non-highway freight bill is the result of: (1) forecasted growth in complementary highway freight transportation, and (2) forecasted decreases in fuel prices.

Expenditures in the other shipper costs category of the Texas freight bill decrease over the entire range of forecasted years as shown in Table 9. Future expenditures for services included in this category such as freight handlers and freight forwarders are forecasted to be significantly smaller than they were in 1975. For example, in 1975 about 6.5 percent of the total non-highway freight bill was composed of other shipper costs. By 1985, this category of other costs is forecasted to be about 4.5 percent of the non-highway freight bill. This trend of decreasing expenditures in the other shipper costs continues through 2000 when approximately .7 percent of the total non-highway freight bill consists of these other costs.

MODAL SHARES OF THE TEXAS TRANSPORTATION BILL

In this section, the modal shares of the passenger and freight transportation bills over the forecast period are each analyzed. This analysis indicates the relative importance of each of the various transportation modes in the future. Several of the transportation modes are shown to have a smaller role in future transportation although both the per capita forecasts and the total forecasts for these modes have been shown to increase over time.

Although total expenditures in most of the non-highway freight categories such as rail, water, oil pipeline, and air are forecasted to increase, the non-highway freight share of the forecasted total freight bill decreased from 23.9 percent in 1975 to about 12.2 percent in 2000. Each of the modal components of the non-highway freight bill are forecasted to decrease as a percent of the total freight transportation bill.

Figure 7 shows the rail freight bill percent of the total freight transportation bill from 1960 through the forecasted years. This shows that the historical trend of rail freight's decreasing share of the total freight transportation bill is forecast to continue. Railroad freight expenditures decrease from 9.3 percent of the 1975 total freight bill to approximately 5.0 percent of the 2000 total freight bill as shown in Figure 6.

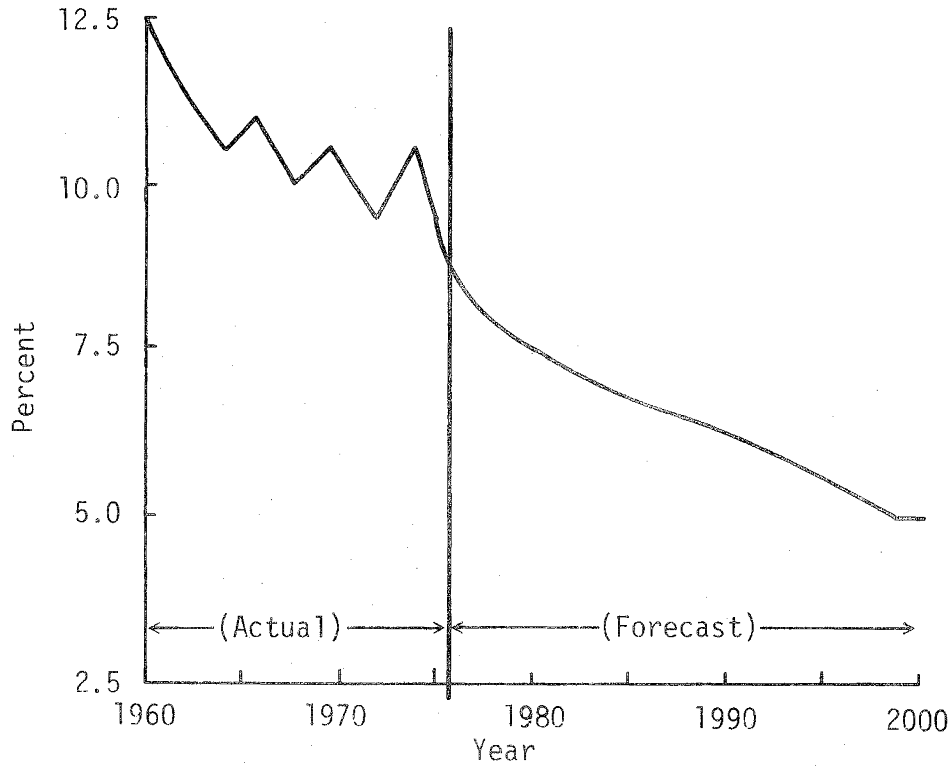

Figure 7. Rail Freight Transportation Bill Percent of the Total Freight Transportation Bill

Figures 8 and 10 suggest that water freight and oil pipeline, respectively, will each have a smaller share of the total freight transportation bill in the future. The historical trends of decreasing shares of the freight bill for each of these modes is expected to continue over the forecasted years. For example, water freight expenditures decrease from 6.7 percent of the total freight bill to 3.3 percent of the 2000 total freight bill (see Table 7). Similarly, oil pipeline transportation expenditures in Texas decrease from 5.8 percent of the 1975 total freight bill to about 3.4 percent of the 2000 total freight bill (see Table 7).

Figure 9 presents both the historical and the forecasted air freight transportation bill percent of the total freight transportation bill. Although the air freight bill share of the total freight bill has generally increased over the 1960-1975 period, the forecast indicates that the air freight bill share will decrease slightly over the forecast period. For example, the air freight bill share of the total freight bill is expected to decrease from 6.2 percent in 1955 to 5.1 percent in 2000. This forecasted decrease in share occurs although the per capita air freight bill as well as the total air freight bill increase over the 1976-2000 period.

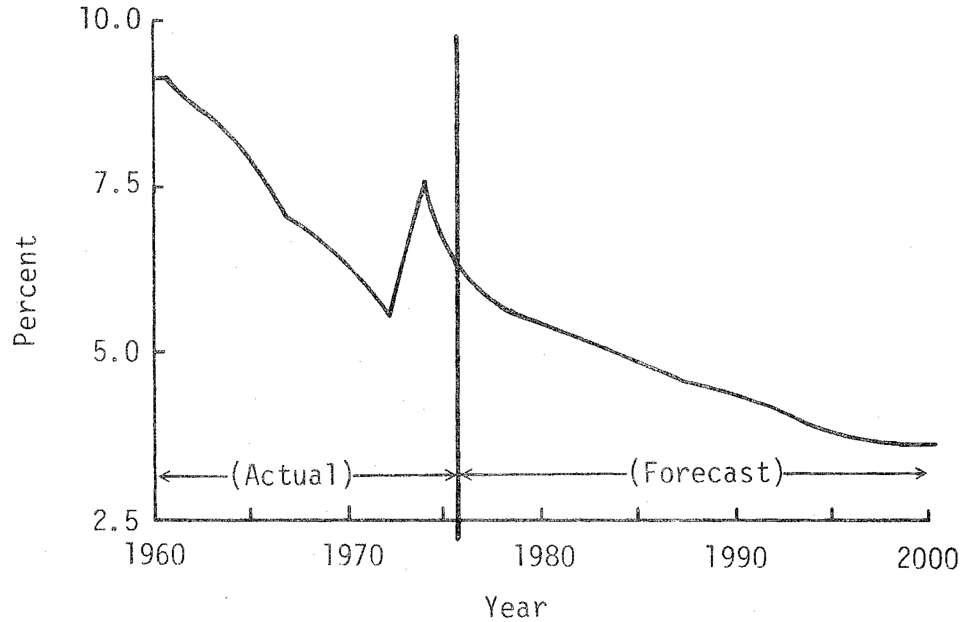

Figure 8. Water Freight Transportation Bill Percent of the Total Freight Transportation Bill

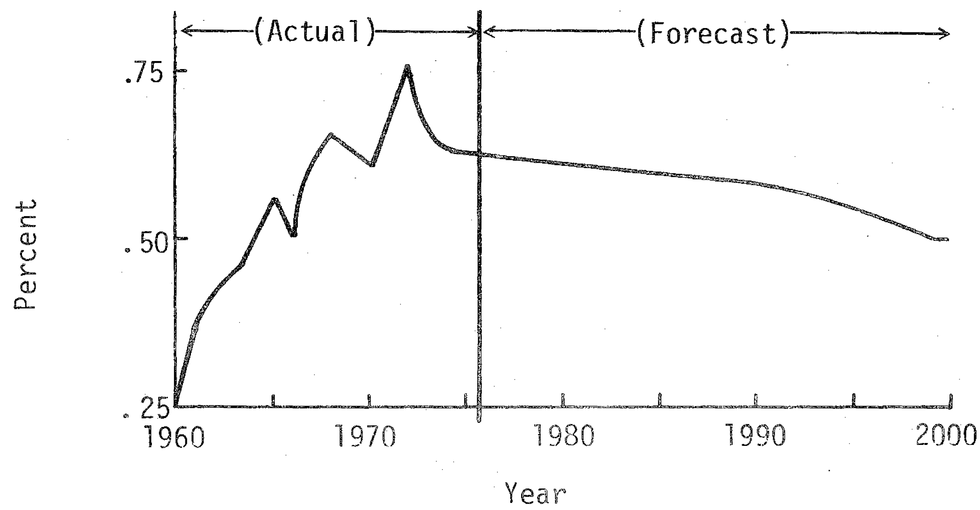

Figure 9. Air Freight Transportation Bill Percent of the Total Freight Transportation Bill

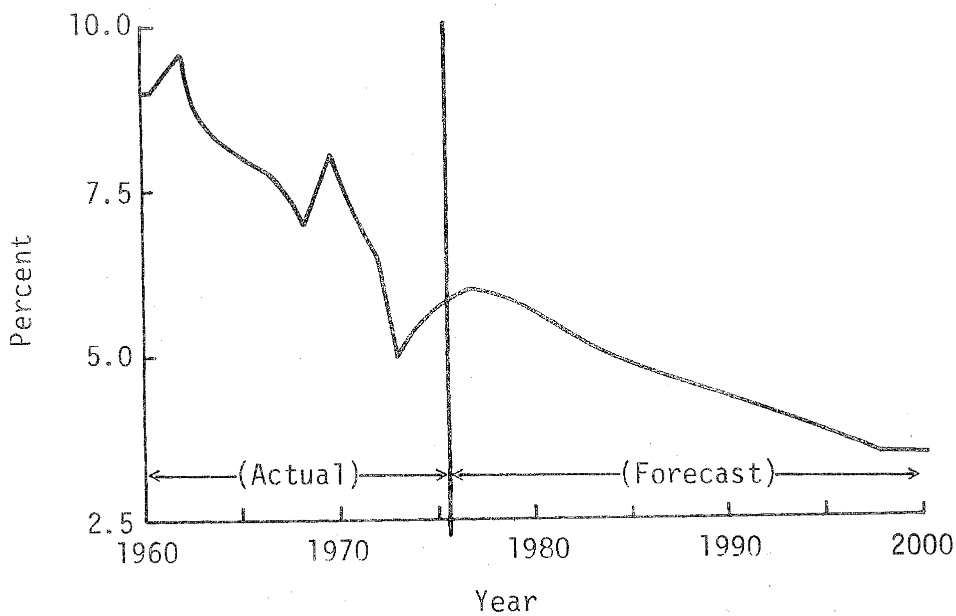

Figure 10. Oil PipeLine Transportation Bill Percent of the Total Freight Transportation Bill

The other shipper cost shares of the total freight bill for the 1960-2000 period are presented in Figure 11. This Figure shows that the decreasing trend prior to 1976, for other costs as a percent of the total bill, is expected to continue over the forecast period. In 1975, other shipper costs comprised approximately 1.5 percent of the total freight bill in the state. By 2000, however, less than .1 percent of the total freight bill consists of these other costs.

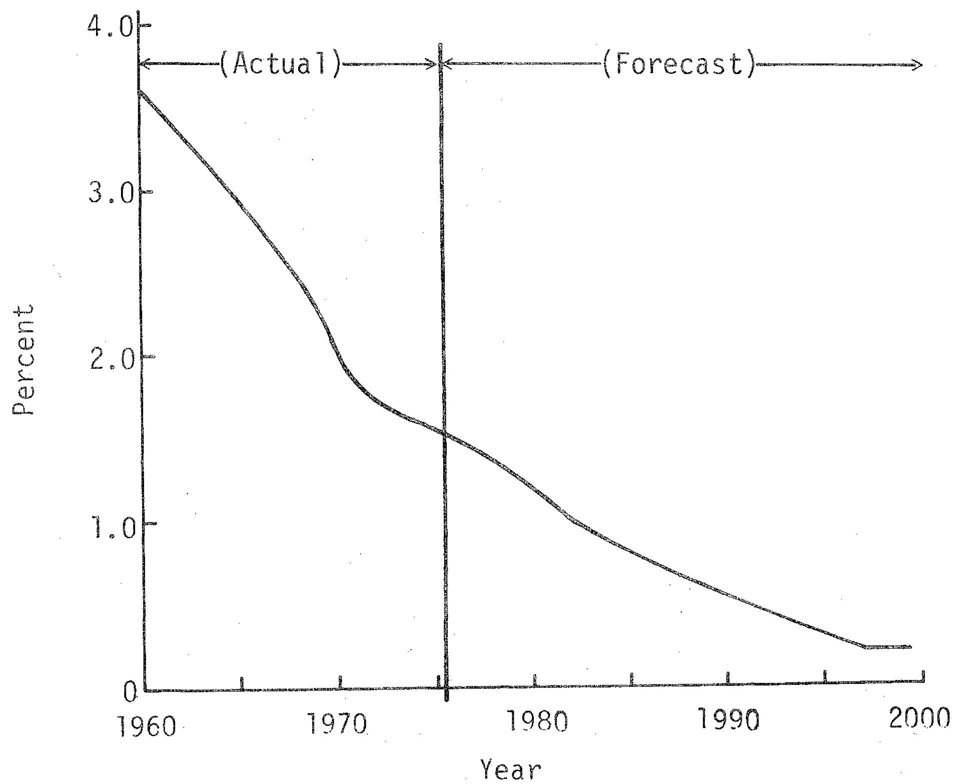

Figure 11. Other Freight Transportation Bill Percent of the Total Freight Transportation Bill

Although the highway freight transportation bill percent of the total freight transportation bill is forecasted to increase, not all of the highway freight transportation modes are shown to increase their future share of the Texas freight bill. For example, intercity trucking expenditures were approximately 32.4 percent of the total freight bill in 1975. In 2000, however, intercity trucking expenditures in the state comprise about 29.3 percent of the total Texas freight bill (see Figure 12).

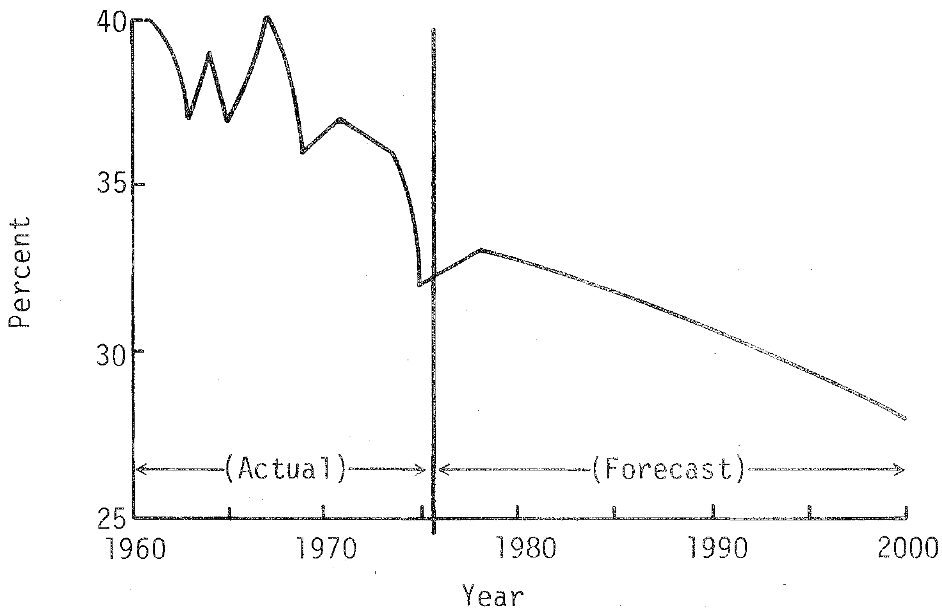

Figure 12. Intercity-Truck Transportation Bill Percent of the Total Freight Transportation Bill

Only the local trucking and bus freight modes show an increase in their relative share of the forecasted total freight bill in Texas. In 1975, local trucking expenditures were approximately 43.6 percent of the total freight bill as shown in Figure 13. The forecast indicates that by 2000, the local trucking bill will be about 59.4 percent of the total freight bill in the state.

Similarly, but on a smaller scale, the bus freight share of the total freight bill is forecasted to increase (see Figure 14). Bus freight was approximately .05 percent of the Texas freight bill in 1975. By 2000, bus freight is expected to increase to .08 percent of the total freight bill.

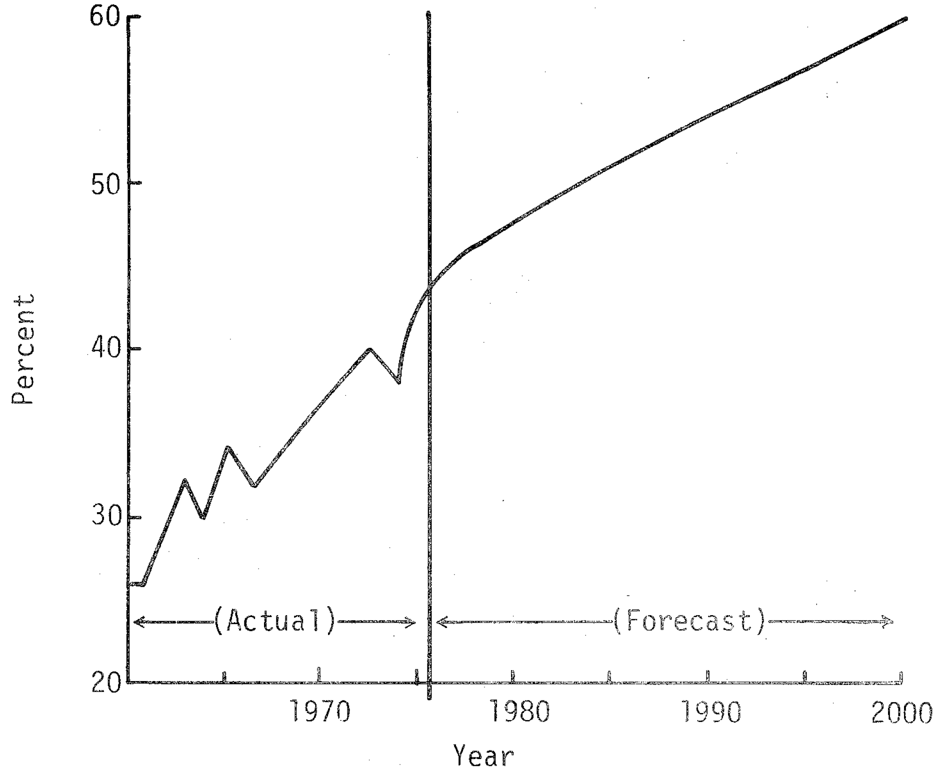

Figure 13. Local-Truck Transportation Bill Percent of the Total Freight Transportation Bill

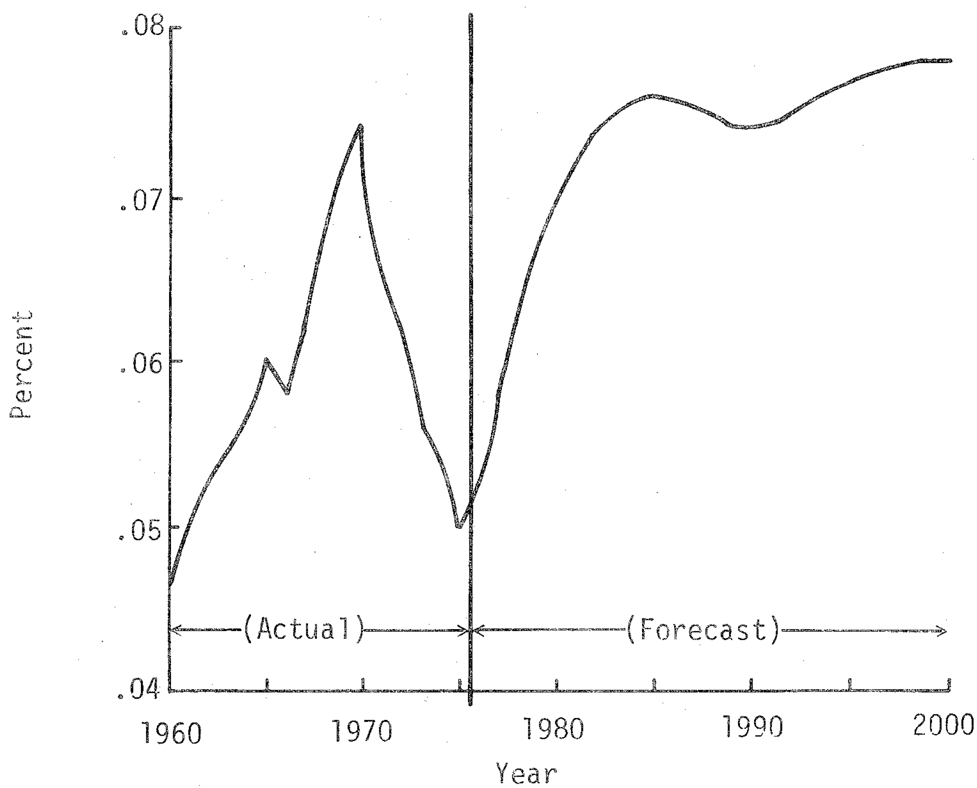

Figure 14. Bus Freight Transportation Bill Percent of the Total Freight Transportation Bill

The analysis of the modal shares of the freight transportation bill indicates that future increases in freight transportation expenditures will occur predominantly in the highway freight transportation category. Further, this analysis suggests that the greatest increase in expenditures will occur in the local trucking mode of highway freight transportation. Therefore, local trucking has a critical part in the state's future transportation system.

Analysis of the modal shares of the passenger transportation bill reveals a passenger mode which has a critical part in the future transportation system of Texas. Figure 15 shows that the total auto bill percent of the total passenger bill is forecasted to increase over the 1976-2000 period. In 1975, the auto transportation bill was approximately 89.7 percent of the total passenger transportation bill in Texas. The auto expenditure share of the total passenger transportation bill is expected to increase to about 90.6 percent by 2000. Figure 15 reveals that the historical share of the auto bill has been subject to the effects of short-run fluctuation in economic activity. Similar fluctuation might occur over the forecast period. However, the forecasted trend in Figure 15 generally abstracts from the effects of short-run fluctuation in economic activity.

The share of other private passenger transportation modes also increases over the forecast period. Figure 16 shows that general aviation expenditures in Texas are forecasted to increase by 2000. For example, the general aviation share of the Texas passenger bill was approximately 1.6 percent in 1975. By 2000, however, the general aviation share of the total passenger bill is expected to increase to about 1.9 percent. This forecasted increase in modal share is the continuation of an historical trend as shown in Figure 16.

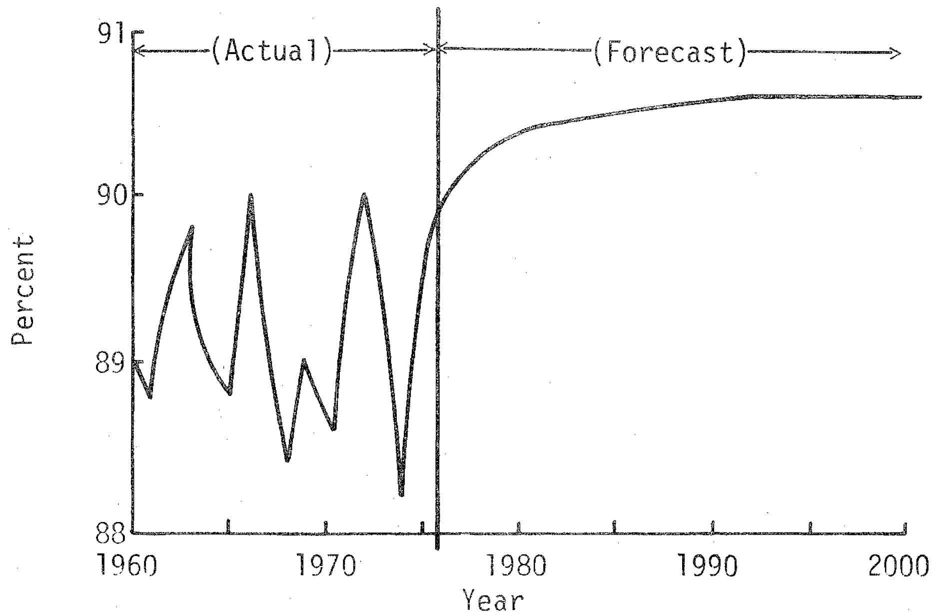

Figure 15. Total Auto Bill Percent of the Total Passenger Transportation Bill

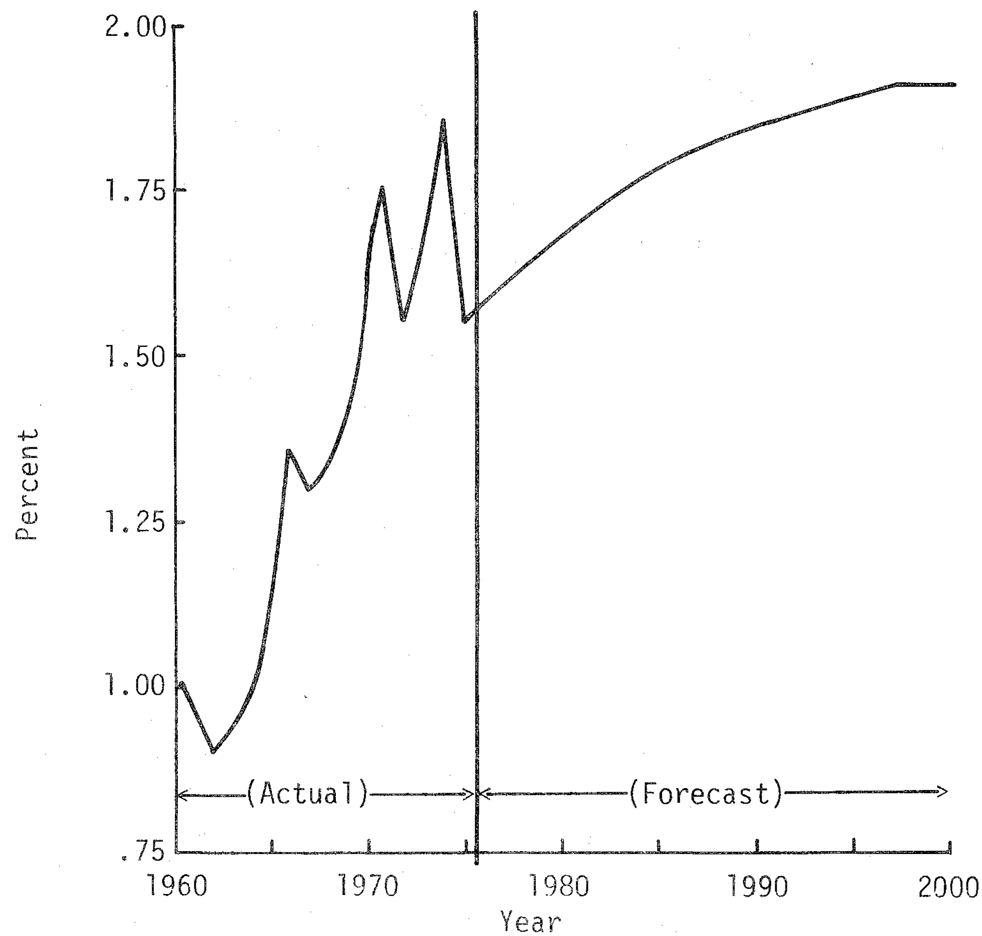

Figure 16. General Aviation Bill Percent of the Total Passenger Transportation Bill

While both of the private modes of passenger transportation expenditures are expected to increase as a share of the total passenger bill, three of the for-hire passenger modal shares are forecasted to decrease. For example, the bus, taxi, and transit bill share of the total passenger bill is forecasted to decrease to zero by 1995. Figure 17 shows that this forecasted decline in the bus, taxi, and transit share is a continuation of the 1960-1975 historical trend.

This forecasted decline in private sector expenditures for bus, taxi, and transit travel in Texas does not imply that after 1995 buses will no longer ply the state's highways and streets. In 1972, for example, TTI data show that only 12 percent of total transit expenditures were derived from government sources. By 1975, however, more than 50% of transit expenditures were funded from governments. Therefore, the forecasted decline in private sector expenditures for bus, taxi, and transit in Texas may be reversed by increases in government subsidies and grants for transit systems in the state.

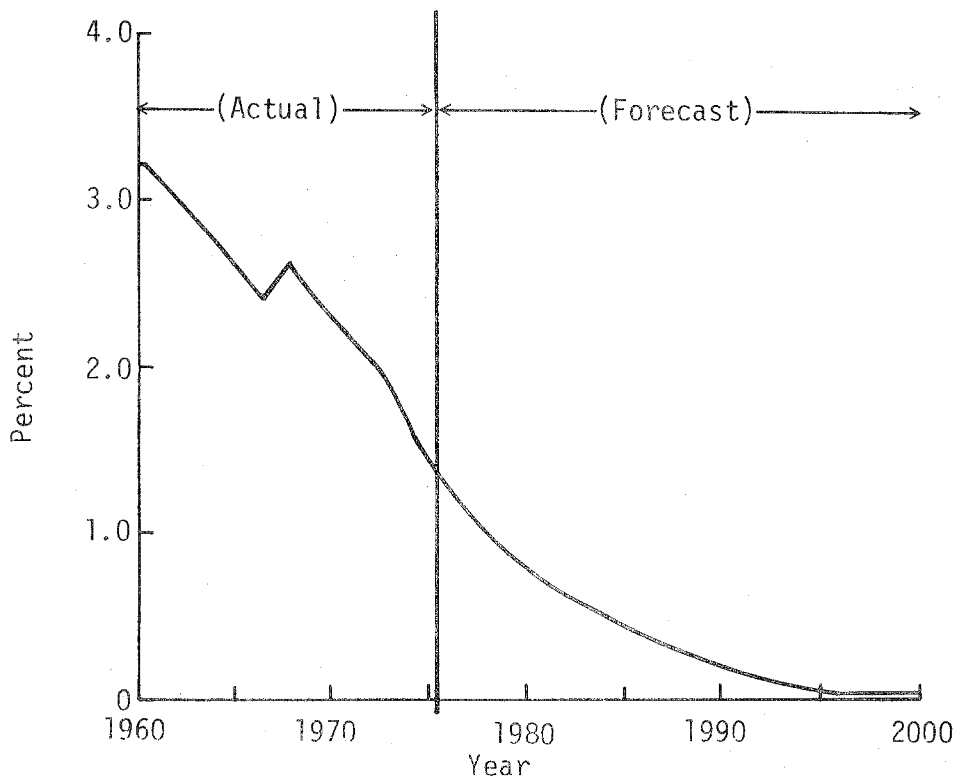

Figure 17. Bus, Taxi, and Transit Transportation Bill Percent of the Total Passenger Bill

The rail passenger transportation bill share of the total passenger bill is also forecasted to decrease. Figure 18 shows that the historical decreasing trend of the rail passenger bill share is expected to continue such that by 1980, private sector rail passenger expenditures will no longer occur.

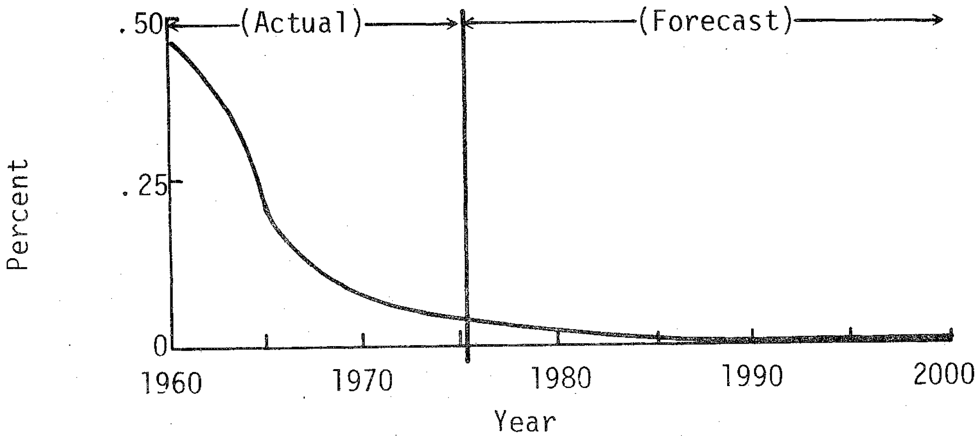

Figure 18. Rail Passenger Transportation Bill Percent of the Total Passenger Bill

Although the air passenger bill percent of the total passenger bill has increased historically as shown in Figure 19, the air passenger bill share is expected to remain relatively constant at about 6.5 percent of the total passenger transportation bill. This consistency in the air passenger bill is expected to quadruple the 1975 level by 2000. The principle reason for this share consistency is the relatively large forecasted increase in the private passenger bill shares of the total passenger bill.

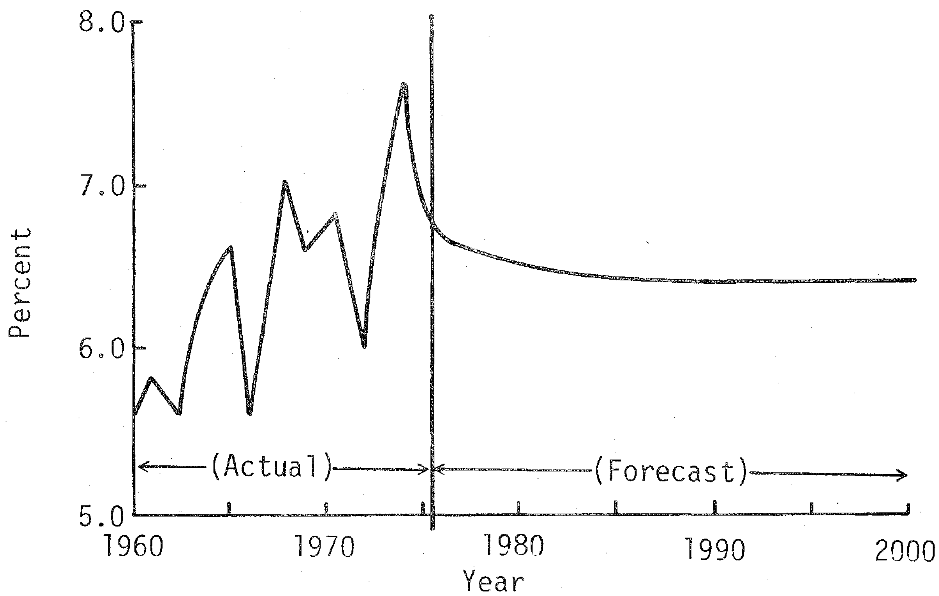

Figure 19. Air Passenger Bill Percent of the Total Passenger Transportation Bill

Figure 20 shows the forecasted school bus transportation bill share of the total passenger transportation bill. School bus expenditures are expected to increase from .59 percent to 1.04 percent of the total passenger bill in 2000.

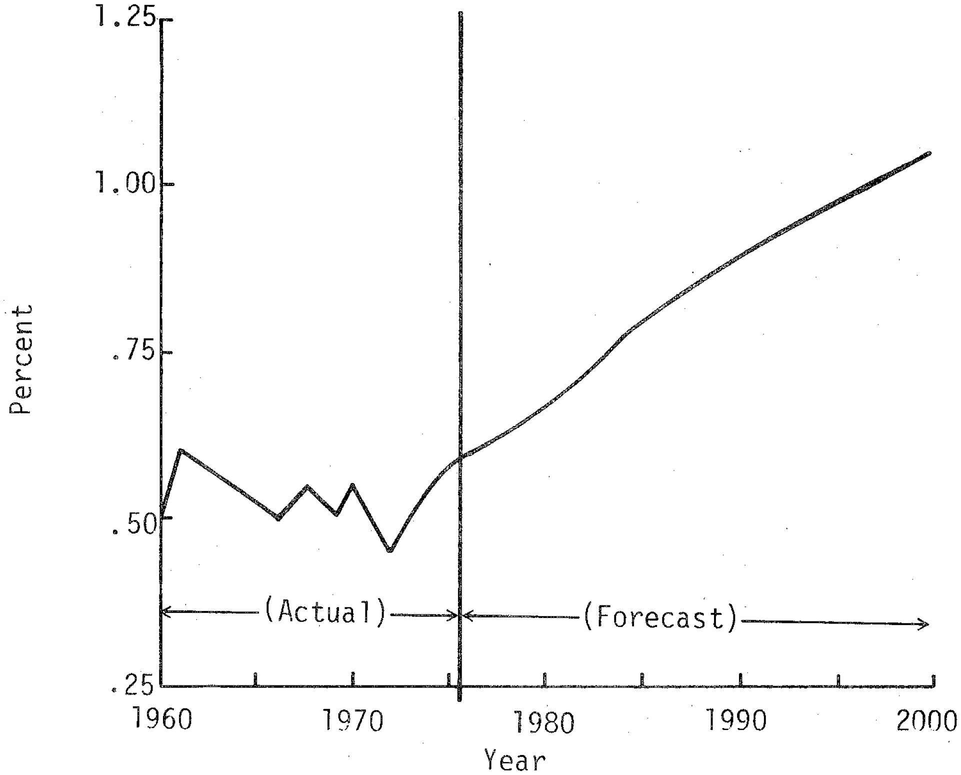

Figure 20. School Bus Bill Percent of the Total Passenger Transportation Bill

The for-hire passenger modes will decrease their shares of the total passenger transportation bill. This trend is shown in Figure 21 below.

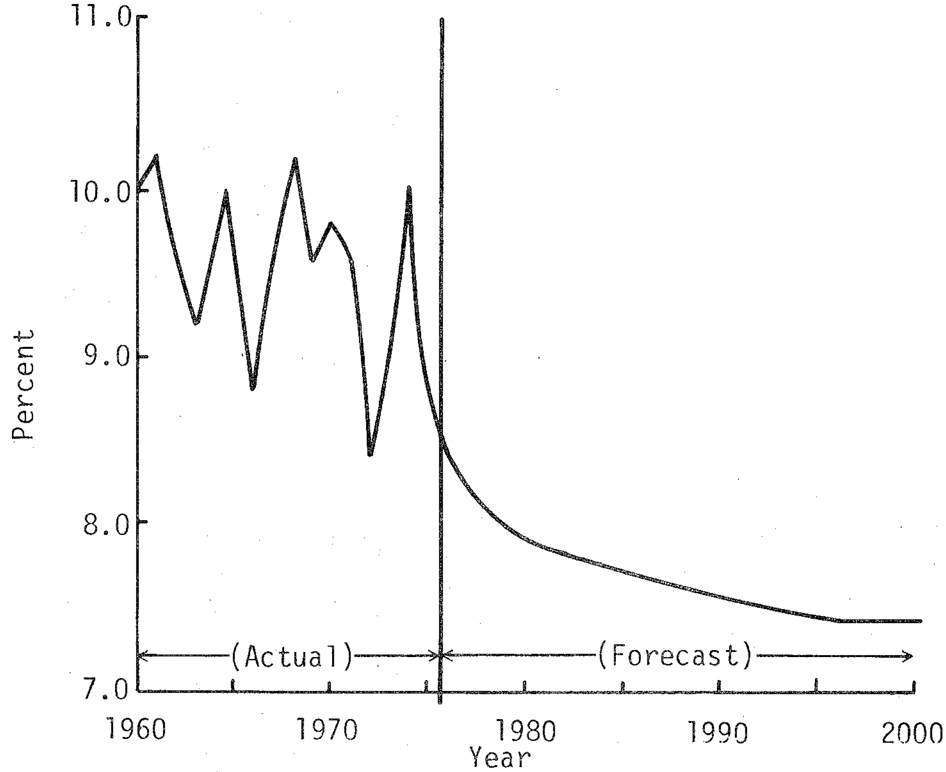

Figure 21. For-Hire Passenger Transportation Bill Percent of the Total Passenger Transportation Bill

SUMMARY OF THE FORECAST ANALYSIS

The future economic environment suggested by forecasts of increasing GTP, decreasing real gasoline prices, increasing Texas interstate miles, and decreasing unemployment influences the forecasted transportation expenditures in the state. These variables, together with forecasted increases in Texas population, imply that transportation expenditures in general will increase in the future as shown in Figure 22.

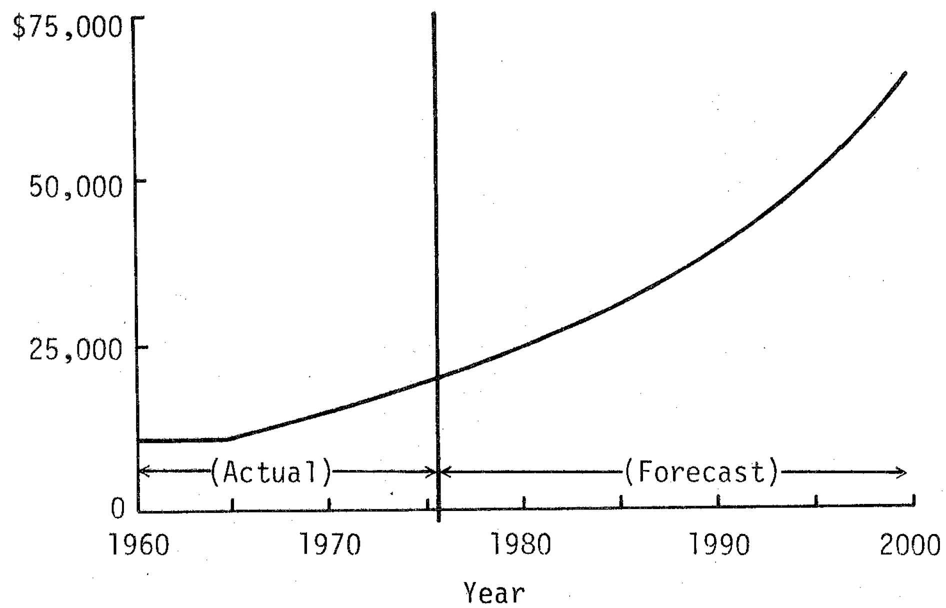

Figure 22. Total Texas Transportation Bill
(In Millions of 1972 Dollars)

The forecasts of the Texas transportation bill suggest that several of the passenger transportation modes (namely rail passenger as well as bus, taxi, and transit) will lose private sector support before 2000. Total expenditures for each of the other passenger transportation modes, on the other hand, are expected to increase by 2000. Additionally, expenditures for each of the freight transportation modes are forecasted to increase.

Analysis of the forecasted Texas transportation bill indicates that both highway passenger and highway freight modes dominate future transportation expenditures. The share of the Texas transportation bill spent on auto and truck transportation will increase relative to the share spent on non-highway movement of passengers and freight. For example, in 1985, 1995, and 2000, the expenditures by the private sector for highway transportation are 87.7 percent, 89.4 percent, and 90.1 percent respectively, of the total transportation bill.

This trend of increasing highway expenditures represents a continuation of the historical data trend. In 1965, the expenditures for transportation by highway modes were 80.6 percent of the total state's transportation bill. By 1975, the highway mode's share of the total Texas transportation bill had increased to 84.0 percent. The trend of increasing highway mode shares of the total bill suggests that highway freight and highway passenger transportation have become more significant in the Texas economy. The forecasts of the various modal expenditures for transportation indicate that the highway modes will have an even more crucial role in the state's economy.

APPENDIX

EXPLANATION OF METHOD USED FOR CALCULATING TEXAS PASSENGER AND FREIGHT BILLS FOR 1959-75

Tables 1 and 2 represent estimates of the direct expenditures or "transportation bill" in Texas for the movement of people and freight respectively. The figures show the relative magnitude of the costs of various transportation modes and at the same time the relative magnitude of the costs of private versus for-hire transportation in the state from 1959 through 1975. Therefore, the information provided by the tables is due directly to the state level characteristics of the data. The following section is a documentation of the sources and methodology used in developing the tables of transportation expenditure data at the state level.

Estimates of the state's passenger bill and freight bill were obtained by employing methodology similar to that used by the Transportation Association of America (TAA) in their data collection for Transportation Facts and Trends [15]. As with the TAA data, each transportation mode was examined separately. Figures were assembled in order to characterize as completely and accurately as possible each mode's direct contribution to the total Texas transportation expenditures.

The state's total passenger bill shown in Table 1 is composed of two major elements, private passenger transportation (automobile) and for-hire transportation (bus, rail and air). Under the heading of private transportation census figures for initial automobile costs, auto maintenance, and operating expenses were gathered at the state level for the respective years [16]. These figures were used in conjunction with tax figures compiled by the State Department of Highways and Public Transportation to arrive at estimates of personal consumption expenditures and producer's durable equipment expenditures for new and used cars. Other components of direct private expenditures in the state such as auto registrations, and license fees were gathered from the U.S. Department of Transportation state level data [17].

The auto insurance expenditures in private transportation were obtained from the state insurance commission [18]. These figures represent insurance premiums paid net of repair claims made by the insured. Double counting of insured auto repairs was avoided by using the net premium figure. The calculation of another large component of private passenger transportation, the interest on automobile owners' debt not included in the initial automobile cost, was made possible by using 15 percent of the annual new and used car sales. In consequence, detailed pictures of the 1959-75 total private passenger bill were constructed.

For-hire passenger transportation, however, was not as easily determined due to the lack of state level data. Bus, airline and railroad operations are not clearly defined at the state level. The exact criteria selected in order to define state operations and the non-availability of state level data created a diversion from the methodology employed by TAA. Although the method by which the figures were generated differs from the TAA approach, it achieved results similar to those that would have been generated using the TAA methodology.

In order to arrive at estimates of bus, taxi and city transit passenger bills in Texas for 1959 through 1975, the Texas input-output study figures were used [19]. The 1967 figures come directly from the study while the remaining estimates for Texas represent updated 1967 figures. Bus, taxi and transit passenger bills were multiplied by the proportion of 1967 to other annual TAA bus, taxi and transit costs for the U.S. [20]. As a result, the updated figures for Texas were derived assuming that the state passenger bill, with respect to intercity and city transit, changed the same as the nation. Expenditures for school bus transportation in Texas were obtained from the Texas Education Agency [21].

Air passenger transportation expenditures in the state for 1959-1975 were calculated by totaling the revenues attributable to Texas operations for each airline serving the state [22]. Total airline revenues were apportioned by the individual carrier's annual percentage of Texas enplaned passengers to total enplaned passengers [23].

The general aviation estimates were obtained from three principal information categories. First, the gross aircraft sales data were obtained from the office of the Comptroller of Public Accounts in Texas. This source was also used to obtain the gross sales of fixed facilities and services related to air transportation which represents the second information category. Finally, the gross sales of aviation fuel were determined by a more indirect method. The consumption of aviation fuel was obtained by multiplying the number of aircraft in service [24] times the average hours per aircraft [25] which, in turn, were multiplied by the average fuel consumption per hour of each aircraft type [26]. The resulting consumption figure was then multiplied by the estimated aviation fuel price for the respective years to arrive at the gross sales of aviation fuel in Texas.

Prior to 1971, the total rail passenger bills were calculated simply by summing the passenger revenues for Class I and Class II rail carriers as reported to the Railroad Commission of Texas [27]. After 1970, almost the entire rail passenger transportation bill was derived from AMTRAK data presented by TTI [28]. Estimates of rail passenger miles are obtained by adjusting 1975 rail passenger miles per line by the percentage change in ridership per line between 1971 and 1975. The AMTRAK portion of the total rail passenger expenditures for Texas was achieved by multiplying the estimated revenue per passenger mile in the same TTI study by the estimated passenger miles. The total figures for the Texas rail passenger bill were calculated by adding the AMTRAK estimates to the passenger revenue data obtained by the Railroad Commission of Texas for non-AMTRAK passenger rail lines.

In this manner, the yearly components of the total for-hire passenger bill for the state in the private passenger bill for the state were calculated. By summing these two figures, estimates of the total passenger bill for Texas as shown in Table 1 were achieved.

The freight bill for Texas was estimated for each transportation mode in a manner which used available data in approaches similar to those taken for the derivation of the state's passenger bill.

Highway freight expenditures were estimated separately for intercity and local transportation. The Texas intercity motor freight bill was estimated by multiplying the percentage of Texas to total U.S. special fuels consumed by the total U.S. intercity motor freight bill for the respective years [17]. While special fuel figures were available from the Federal Highway Administration of the U.S. Department of Transportation, the national intercity freight expenditures were readily obtainable from TAA [20]. Since the majority of intercity motor freight is carried by trucks operating on special fuels, the methodology for obtaining the intercity estimate is sound. The local truck bill for 1959-75 was determined by multiplying total urban truck-miles [17] by estimated average cost per mile [29]. The cost per mile was multiplied by a weighting factor of 8 for vehicles one-ton or less and by a weighting factor of 2 for 1-1½ ton vehicles (the factor being the relationship to total vehicles [30]) and divided by the sum of the factors, and to which is added the estimated driver cost. The same driver cost per mile figures used in the TAA methodology were used in the TTI calculation [31]. This driver cost was updated in direct proportion to the average union wage increases for the respective years [32].

Railway freight data was much more readily available at the state level. The transportation bill of freight by rails for Texas was obtained by summing the freight revenues of all Class I and Class II railroad line operations within the state .

Yearly estimates of the state's water transportation bill were basically drawn from the 1967 input-output study for Texas [19]. The 1967 water transportation output was used for the 1967 water transportation bill while the 1967 water transportation output was used to yield estimates for the remaining years. The ratios of wholesale price indexes [32] and port tonnage for 1959 72 [33] and for 1973-75 [34] were multiplied by the 1967 water transportation output figures in order to achieve the 1959-75 water transportation estimates.

Air freight transportation figures were calculated in a manner similar to the air passenger transportation bill mentioned earlier. The state's air freight expenditures represent a portion of total airline freight revenues [23] allocated on the basis of the percentage of state enplaned freight tons to total enplaned tons for each air carrier [22].

A method similar to that used to calculate the water transportation bill for both years was employed to arrive at the state's pipeline transportation bill for 1959-75. For 1967, the input-output study dollar output figure was used [19]. The figure was transformed to yearly pipeline bill estimates by the proportional change in estimated state level revenues calculated for each of the years. The estimated state revenues were based upon the known wages paid by pipeline companies in the U.S. for the respective years [35]. Since total U.S. pipeline wages were known along with the total U.S. pipeline revenues, the same ratio was assumed to hold for the state.

A category of "Other Freight Costs" was included which is analogous to the combined categories of "Other Carriers" and "Other Shipper Costs" found in the TAA study [20]. The proportion of the total U.S. freight bill which excludes other carriers and other shipper costs to the costs mentioned in the two categories was calculated for the U.S. from TAA data. The calculated annual proportions were then multiplied by the sum of all other freight bill categories for each respective year to reveal the "Other Freight Costs" for Texas.

Although a few small portions of the total state transportation bill may have been omitted, there are no good methods to arrive at accurate figures for them. The figures generated and presented in the study represent the major transportation modes and their respective freight bills.

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