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16. Abstract

The economic significance of transportation in Texas is highlighted by the relationship between total private expenditures for transportation and economic activity in the state. This report contains estimates of the Texas transportation expenditures from 1959 through 1976 by mode.

These estimates show the growth in total transportation expenditures and the shifts in the relative magnitudes of expenditures for the various passenger and freight transportation modes. A comparison between the Texas transportation bill and Gross Texas Product is presented to illustrate the trends in transportation expenditure shares of the state's total output. Additionally, a comparison between the U.S. transportation bill and the Texas transportation bill reveals the relative intensity of transportation expenditures in the U.S. and Texas.

The effects of population growth are removed by presenting the Texas and U.S. transportation bills in per capita terms. These per capita transportation expenditures show the relative magnitude of micro-level expenditures for each transportation mode. The Texas per capita bill, along with gasoline price, per capita Gross Texas Product, and a price index are variables in functional relationships which are used to forecast future transportation bills. The forecasting equations specify the relationships between the state's transportation bill and other economic variables.

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THE ECONOMIC SIGNIFICANCE OF TRANSPORTATION

by

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and

William F. McFarland

Research Report 227-1

Transportation, Population and Economic Growth

Research Study Number 2-1-77-227

Sponsored by

STATE DEPARTMENT OF HIGHWAYS

AND PUBLIC TRANSPORTATION OF TEXAS

TEXAS TRANSPORTATION INSTITUTE

TEXAS A&M UNIVERSITY

COLLEGE STATION, TEXAS

September 1977

EXECUTIVE SUMMARY

A. Four methods of measuring the significance of transportation in the economy of Texas are discussed. They are the Census Approach, Wages Approach, Input-Output Approach, and the Transportation Association of America Approach. Each method has specific advantages and shortcomings when used to determine the relationship between transportation and economic activity over a period of time.

B. This paper presents Texas' transportation "bill" for the years 1959-1976, estimated using methods similar to those used by the Transportation Association of America to calculate the United States' total transportation bill. The total Texas transportation bill, which is the sum of the Texas passenger and freight transportation bills, is an estimate of the private expenditures for transportation in Texas. In turn, passenger and freight transportation bills are composed of estimates of transportation expenditures by each transportation mode (highway, rail, air, water, pipeline).

C. These estimates show:

1. The total Texas transportation bill was $6.4 billion in 1959 and $23.5 billion in 1976. The current dollar increase in the total transportation bill was 367 percent while the constant dollar increase in the total Texas transportation bill was 90 percent between 1959 and 1976.
2. Texas' freight transportation bill was $3.3 billion in 1959 and $11.7 billion in 1976, which shows an increase of 355 percent in current dollars and 81 percent in constant dollars.

3. Texas' passenger transportation bill was $3.1 billion in 1959 and $11.8 billion in 1976. These amounts represent an increase of 381 percent in current dollars and 98 percent in constant dollars.

D. A comparison between the estimates of the Texas transportation bill and the Gross Texas product show:

1. The total transportation bill was 26.8 percent and 26.7 percent of GTP in 1959 and 1976, respectively.
2. Texas' freight transportation bill was 13.9 percent and 13.3 percent of the state's gross product in 1959 and 1976, respectively.
3. Texas' passenger transportation bill was 12.9 percent and 13.4 percent of the state' gross product in 1959 and 1976, respectively.
4. These percentages imply that the total Texas transportation bill and GTP relationship has been relatively constant.

E. A comparison between the Texas and U.S. transportation bills shows:

1. The total Texas transportation bill represented 6.27 percent of the U.S. total transportation bill in 1959 and 6.41 percent of the total transportation bill by 1974. The Texas gross product increased from 4.95 to 5.15 percent of Gross National Product between 1959 and 1974.
2. The freight bill portion of the total transportation bill in 1959 was 46 percent and 52 percent for the U.S. and Texas, respectively. The freight bill portion of the total transportation bill for the U.S. did not change between 1959 and 1974. The freight bill portion of the total Texas transportation bill decreased to 50 percent in 1974.
3. The passenger bill portion of the total transportation bill in 1959 was 54 percent and 48 percent for the U.S. and Texas, respectively.

These portions had changed in 1974 to 54 percent and 50 percent for the U.S. and Texas, respectively. The Texas passenger bill increased more than the U.S. passenger bill as a percent of the total transportation bill.

F. Equations used to forecast the Texas passenger, freight and total transportation bills are presented in this paper. Additionally, forecasts of the Texas passenger, freight and total passenger bills through 1990 are developed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GENERAL ECONOMIC SIGNIFICANCE OF TRANSPORTATION

The economic implications of transportation are best described by four interrelated roles:

1. transportation and prices,
2. transportation and production,
3. transportation and distribution,
4. transportation and economic development.

After a brief discussion of each role, various methods of determining the economic significance of transportation will be examined.

TRANSPORTATION AND PRICES

Transportation affects prices through direct transportation cost contributions. Studies made by the Interstate Commerce Commission show that a substantial share of the price of any item is due to the cost of shipment [1]. This includes the cost of transporting raw materials to the production site and the cost of shipping the finished product to market.

The cost of transporting items depends, to a large degree, upon their physical characteristics. For such commodities as sand or gravel, the transportation cost makes up over half of the final product price. On the other hand, some lighter and higher unit-valued items such as business machines or calculators have low transportation costs relative to price. On average, twenty cents out of each U.S. consumer's dollar spent on consumption goods goes to transportation [1].

Transportation also affects prices in more indirect ways. One way is by contributing to price stability in local market areas. Long-haul transportation causes markets and hence market prices to be less responsive to local supply and demand conditions by ameliorating the price destabilizing effects of local market demand and supply changes. For example, if prices rise in a regional market due to a decline in local supplies or an increase in local demand, an influx of supply via long-haul transportation may occur. As more distant suppliers contribute to the local market, the market price is subject to downward pressure.

By allowing more suppliers to enter a given market, transportation promotes price competition. Suppliers with the lowest production costs plus transportation costs set the market price. Others must either meet the low-cost supplier's price or else lose their market share. In addition, transportation promotes competition and lowers prices in local markets via entry of more distant suppliers.

The relationship between product prices and transportation costs influences the usage and the price of land. Good transportation allows land to be used in a variety of ways. In other words, improved transportation increases the value of land by increasing the number of economically viable productive alternatives of land usage. Transportation improvements that lower transportation costs relative to final product price, then, increase the value of land yield and increase the number of alternatives for land use. The increase in land value is translated into higher prices for land. This same principle applies to other natural resources and their price relationship with transportation.

In summary, transportation cost is a component of all prices. Transportation promotes price stability and stimulates price competition. Transportation also influences the value and thus the price of natural resources.

Transportation and Production

Raw materials or other inputs have no value unless they are transported to the locations where they are used in production. In the productive process inputs are brought together in the right proportions at the right place to produce goods. Value in the form of final products is created by changing the location of inputs so that production can occur.

Transportation also creates value by enabling the inputs to be added to the productive process at the proper time. If inputs are not available at the right time, production costs increase. Two cost-reducing solutions exist. Either large inventories of inputs may be held until they are used in the productive process, or the transportation of input supplies might be improved to achieve better input timing. In the first cost-reducing solution, transportation is still necessary for the movement of inputs for inventory accumulation. The second solution, however, requires an actual reduction in input inventory holdings along with an increase in the speed and reliability of input movement.

Large-scale production often yields lower per-unit costs of output than small-scale production. Transportation enables large-scale production to be carried on by allowing the tremendous amounts of inputs required to be brought to the place of production. The huge amount of output of our current productive system is the result of these large-scale operations which are in turn dependent upon transportation.

Since geographical regions are not equally endowed with resources or climate, production processes in one particular region may differ from processes in other regions. Some regions possess a comparative advantage in the production of certain items while other geographical areas have comparative production advantages in other items. As a result, regional specialization in production occurs. This form of specialization would not be possible without transportation. The specialized goods of each region are traded to other regions via transportation. If this exchange did not take place, each region would be required to devote some of its resources -- which could have been used in the production of specialized products -- to self-sufficiency production. The general cost of production would rise if transportation were inadequate to permit regional specialization.

Since Alfred Weber in the early 1900's, economists have theorized that transportation costs are a major determinant of industrial location. Production facilities are observed to be located upon consideration of input transportation costs and output transportation costs. All other factors constant, if output transportation costs are small relative to input transportation costs then the industry will be material oriented and locate near input supplies. If output transportation costs are high relative to input movement costs, then the industry will be market oriented and locate near output markets [2].

Transportation costs may be viewed as a cost of production and may hence be an integral part of the productive process. Input movement has been shown to promote production by permitting adequate inputs to be assembled at the most propitious place and time. Transportation costs were shown to determine not only what is produced but the location of production as well.

Transportation and Distribution

Produced goods are of little value unless they can be moved to the place where they are demanded. Transportation creates value in output by enabling the producer to move his products to market. In addition, it enables the producer to move his goods to market at the proper time. In essence, transportation is important in the prevention of market surpluses and shortages of goods.

Specialized and large-scale production can occur only if mass distribution of output is available. Transportation improves buyer accessibility to products and broadens markets to bring about mass distribution of products. Therefore, lower per-unit production costs are realized as a result of transportation influences upon distribution [1].

Transportation enhances both production and consumption through the distribution of goods. It allows an efficient exchange of a greater variety and volume of commodities. For example, improved transportation has yielded wider market areas or broader distribution for perishable items produced at locations far from market areas.

Just as transportation is seen to be a determinant of the location of production, it is viewed as a determinant of the location of markets. Market areas of producers are dependent upon shipping costs. As costs fall, producers may participate in more distant markets. Conversely, high shipping costs exclude more distant suppliers from local markets and hence local markets become more restricted to local suppliers.

In summary, the cost of transporting goods to market may be considered a part of the cost of distribution. Therefore, transportation and distribution are as closely linked as transportation and production.

Transportation and Economic Development

The relationship of transportation to production and distribution is both direct and crucial. Large-scale production and mass distribution have been shown to depend upon relatively low-cost transportation. The tremendous gains in economic growth on both state and national levels are directly due to an accumulation of large production capacity and a broad distribution system. Transportation, therefore, provides a foundation upon which the development of the economy depends. Just as production and distribution improvements are required for economic growth, the transportation foundation must also be improved. If no new efficiencies occur in the transportation sector and the transportation system remains unimproved, then the burden of economic growth falls solely upon other production and distributional efficiencies.

Long-term economic growth is enhanced by price stability and competition. Price stability may influence confidence in the economic system and stimulate the investment necessary for economic growth. On the other hand, competition represents the freedom to take advantage of investment opportunities in the economy. Transportation plays a vital role in price stability and competition, thereby being a key factor in economic development. If transportation is neglected, the entire economic growth pattern will be affected.

MEASURES OF ECONOMIC SIGNIFICANCE

There are many techniques which might be used to yield information about the role of transportation in the Texas economy. All of the techniques present problems of varying degrees with regard to either the completeness and consistency of the source data or the economic implications revealed by the data itself. In this section, the following alternative sources and methodologies in determining the relationship between the state's economy and transportation will be discussed:

1. The Census Approach,
2. The Wages Approach,
3. The Input-Output Approach,
4. The Transportation Association of America Approach.

The method selected for use in this study will be examined with respect to attendent problems in its use.

THE CENSUS APPROACH

The U.S. Department of Commerce publishes a Census of Transportation at five-year intervals, the last available census being published in 1972. Data included in the census is presented in three separate reports:

1. "National Travel Survey",
2. "Truck Inventory and Use Survey",
3. "Commodity Transportation Survey".

Each of the reports contains state and national level information pertaining only to the census years.

The "National Travel Survey" includes such data as the number of persons taking trips, the number of trips taken, and the number of person-miles traveled.

Basically, this report presents information regarding the socioeconomic characteristics of travelers. The information provided in this publication might be used to gain insight as to who generally travel and what factors influence their travel demand. The use of the "National Travel Survey" to generate a state level scenario of the economic significance of transportation is hindered by two considerations. First, this report only presents data on travel for the nation as a whole and for nine travel regions; no specific Texas data is available. This problem may be overcome, however, by assuming that Texans behave the same as members of the travel region that includes Texas. The second problem concerns the frequency of census publication. Due to the five-year intervals between census publications, good time series data is unobtainable. Intercensus estimates of the data are required to adequately characterize the economic relations of transportation. The few observations that are available yield sketchy conclusions with regard to transportation's role in the Texas economy.

The "Truck Inventory and Use Survey" portion of the Census of Transportation concerns specifically the characteristics and uses of private and commercial truck resources. This report contains state and national level data on the number of trucks, major truck uses, annual vehicle-miles, range of operation, and the types of fuel used by various truck categories. State-to-state or state-to-nation comparisons might be made using the "Truck Inventory and Use Survey" since much is revealed about the specific characteristics of truck fleet operations. The use of this survey restricts the analysis to the trucking industry and to essentially a non-time-series approach. Trucking characteristics may be compared at a point in time, but the long-term dynamic relations between the economy and trucking are not easily ascertained.

The "Commodity Transportation Survey" deals with the shipment of commodities by manufacturers. This report covers the flow of various commodities in tons and ton-miles by transportation mode for each census year. An approximation of the relative importance of the various transportation modes in total freight hauled may be made from the report. There are, however, certain drawbacks to using the "Commodity Transportation Survey" to establish the economic importance of transportation. Since the report presents only ton or ton-mile shipments which originate in the state, no exact determination of the economic relations of transportation are manifest. Commodity ton or ton-mile shipment originations do not specifically point to the economic effect, in terms of dollars of transportation. Another problem has to do with time-series analysis of economic relationships, i.e. there simply are not enough observations to reach sound conclusions about the economic significance of transportation.

Other parts of the Census of Transportation provide information which may help in the assessment of the economic role of transportation. The Census of Retail Trade and the Census of Wholesale Trade allude to the dollar impacts of specific industries, such as auto dealerships and auto repair, upon the economy. As with the other census publications mentioned, the information is not adequately descriptive of time-series economic relationships. In addition to the lack of observations over time, the data is only applicable to a few specific segments of the transportation sector.

Although the census data is not completely descriptive of the importance of transportation, the information has been used in a supportive role. In several instances, census data has proved helpful in determining the "Transportation Bill" for Texas.

The Wages Approach

Wages and salaries of 1974 are shown by the Department of Commerce to constitute approximately 65.7 percent of total national income [3]. Generally, the ratio of wages to national income has been fairly constant. As a result of a wage-to-income relationship, inferences can be made with regard to the wages paid to the transportation sector and the total income of the economy. Some idea of the significance of transportation might be inferred from the wage-income comparison.

An extension of the methodology to the state level may not yield a good indication of economic significance. The consistency of the wages-to-income relation at the state level might not hold over time. Business fluctuations probably change the state level transportation wage-to-income percentage more than they change the national level percentage. As a result, the business cycle would obscure the true economic significance of transportation at the state level.

Although the Texas Employment Commission does collect time-series data on wages paid by the transportation sector in Texas, the information is not complete. For example, wages paid by the motor freight departments of retailing and wholesaling businesses are not included. Studies have indicated that these private non-regulated carriers may account for a significant portion of total highway transportation expenditures [4]. The significance of private auto transportation to the Texas economy is also not fully disclosed by the wage-income method. Even if all wages paid to support private auto transportation were considered, the role of private auto transportation in the state's economy would be understated.

If transportation sector wages for the state are compared to total wages paid in Texas, the significance of transportation is understated. Although transportation services do provide the economy with an important source of direct income, namely wages, full expenditures for transportation are not considered with the wages approach. A better method of obtaining the full "transportation bill" is needed.

The Input-Output Approach

The input-output technique yields a systematic display of each economic sector's purchases of inputs and sales of outputs. Input-output models have been developed in recent years for various state economies. Models have been constructed specifically for the Texas economy for 1967 and 1972 by the Office of the Governor.

The transportation dollar inputs bought by other economic sectors are presented in the Texas Input-Output studies. The economic significance of transportation in the state's economy may be disclosed by analyzing transportation's relative share of all sector inputs. For example, such sectors as agriculture, mining, construction, and manufacturing use transportation as an input. Sector input purchases of transportation services and the relative magnitude of these purchases to other input purchases might be used to determine the role of transportation in the Texas economy.

Input-output studies may also be used to develop input multipliers for the various other sectors of the economy. The multiplier for transportation in turn may be used to estimate the economic impact of a dollar increase in transportation input expenditures.

Certain shortcomings are apparent when input-output studies are used to analyze the importance of transportation. In the Texas input-output study private automobile sales and service are not included in the transportation sector; they are placed in the retail trade sector. In addition, private not-for-hire trucking is excluded from the study. This approach, therefore, has one of the drawbacks of the wages approach in that private transportation is excluded. The input-output approach also has a shortcoming found in the censal approach, i.e. the small number of observations do not allow good time-series analysis.

The Transportation Association of America Approach

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. Hence, unlike several of the approaches mentioned previously, private sector transportation costs are considered.

The importance of transportation to the nation's economy is supported by the close relationships among different transportation and economic statistics. For example, TAA has developed data that show the close relationship between the nation's Gross National Product and Freight Transportation Bill. A similar approach may be developed for the state by determining the Texas transportation bill relationship to Gross Texas Product.

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.

Use of the TAA methodology yields other benefits as well. Each transportation mode, such as highway, rail, water, air and pipeline, can be analyzed separately. In addition to the modal comparisons, state and nation comparisons might be made since the same methodology is applied to obtain transportation bills at both levels. The presence of methodological consistency is an important factor in the determination of transportation's relative role in the U.S. and Texas economies.

Although the TAA approach includes almost the entire transportation sector, some areas are not accounted for in the analysis. In particular, there is no break-down of public transportation expenditures by different levels of government. Property taxes and general fund revenues used for highway maintenance and construction are not included. A more detailed list of transportation and transportation-related areas might improve the accuracy of the state and national level estimates of the transportation bill. The gain in accuracy stemming from the inclusion of the omitted areas would be relatively insignificant.

Because of certain characteristics of the TAA methodology that make it preferable to the other three methods with respect to the aims of this report, the TAA methodology will be followed here. These characteristics include:

1. the assumption of a private sector viewpoint,
2. the consistency of data areas, allowing state-to-nation comparisons,
3. the small gain in transportation bill accuracy resulting from the inclusion of other areas.

This study presents the TTI estimates in a form which enables the state transportation bills to be easily compared with the TAA national transportation bills. In addition, the TTI estimates may be readily augmented to include all of the transportation sectors in the economy.

A discussion of the historical economic setting precedes the presentation of the Texas transportation bill estimates. The knowledge of economic trends in both Texas and the U.S. facilitates the analysis of the estimates.

ECONOMIC BACKGROUND

A brief description of the economic conditions which prevailed during the years included in the study will be helpful in understanding the relationship between the economy and transportation. The following characterization of events which influenced the economy generally applies to Texas as well as to the U.S. economy as a whole.

The economic environment in the years immediately preceding 1959 set the tone for the decade of the sixties. In 1957 and 1958 the nation experienced a recession which dampened the generally optimistic business outlook following the Korean War. Much of the industrial capacity expansion resulting from the post-Korean War period was idle during 1957 and 1958. Excess industrial capacity and depressed output demand set the stage for the years studied. Another recession between 1960 and 1961 served to further retard the demand for outputs.

The period from 1961 through 1969 can be divided into two subperiods. The first covers the years 1961 through 1965, marking the triumph of discretionary fiscal policy or "New Economics" of the Kennedy-Johnson administrations. Final achievement of almost full employment (approximately 4 percent) occurred by the end of 1965. Over the 1961 through 1965 period the economy was not hampered by inflation; for example, the Consumer Price Index rose at an average annual rate of only 1.3 percent. The second period includes the remainder of the 1960s, and was dominated by demand-pull inflation. Fiscal policy excesses and the escalation of government expenditures associated with the Vietnam War are a few of the reasons behind the relatively rapid inflation. The Consumer Price Index rose at an average annual rate of from 5 to 6 percent. Throughout the second period the demand for U.S. goods abroad deteriorated. Pegged U.S. dollar exchange rates and a high U.S. balance of payments deficit together with growing domestic inflation combined to make U.S. goods less price competitive with foreign goods. From late 1968 through 1970 the U.S. slipped into another severe economic recession. This recession was largely the result of an extremely tight monetary policy administered to stem inflation and the balance of payments deficit [5].

In the early 1970s, the nation experienced a general rise in real disposable income which resulted in an increase in the domestic demand for goods. Additionally, the demand for U.S. exports was increased due to the decision in 1971 to allow the U.S. dollar to "float." The floating exchange rate allowed the prices of U.S. goods to fall in relation to foreign goods and as a result U.S. goods became more attractive to foreign purchasers. For example, the exportation from the U.S. of large quantities of grain and other agricultural products occurred after the U.S. dollar was allowed to float.

The increased domestic and foreign demand for U.S. goods resulted in rapid inflation which was subsequently combated by wage and price controls from late 1971 until early 1974. The implemented wage and price ceilings created stunted business profits and depressed capital expansion as the return on investment was forced down. Businesses failed to make capital expansion investments during the early 1970s for the following general reasons:

(1) the tight money policy adopted by the Federal Reserve System increased interest rates and thus increased the cost of capital,

(2) shortages of goods which resulted from the imposition of price celings made capital expansion difficult,

(3) environmental controls increased the cost of production while not increasing productive output.

Business was further depressed by the 1973 Arab oil embargo which created shortages of the major source of U.S. energy.

In 1974, as the wage and price controls were removed, a severe recession struck the U.S. economy. The simultaneous appearance of a high rate of inflation and a high rate of unemployment during the recession represented a contradiction to traditional economic theory. Economists seemed hard-pressed to obtain such "stagflation" results from their theories of the operation of the economy. The recessionary problems of 1974 subsided gradually in 1975 and 1976 as economic recovery began.

The relationship between transportation and the economy was influenced by the level of business activity and other factors as well. For example, the antipollution legislation of the early seventies resulted in reduced automobile gasoline mileage. Rising gasoline prices and reduced vehicle gasoline mileage combined to increase the cost of private auto and truck transportation.

An analysis of fuel prices before and after the Arab oil embargo reveals some interesting implications with respect to transportation. Gasoline prices reflect the prices of all petroleum fuels and petroleum fuels are, in turn, a vital input to transportation. As shown in Figure 1, the real price of gasoline fell until 1973. This price decline implies that the cost of fuel intensive transportation modes may have declined relative to the cost of other less fuel intensive transportation means. Additionally, since all transportation modes use petroleum fuels to some degree, the overall cost of transportation relative to other costs may have declined.

After the Arab oil embargo, the real price of gasoline and other petroleum fuels increased dramatically. The impact of real fuel price increases along with the effects of other economic characteristics upon transportation will be discussed in greater detail later in this study. Specifically, the role that economic factors play in the size and type of transportation expenditures made in Texas will be described.

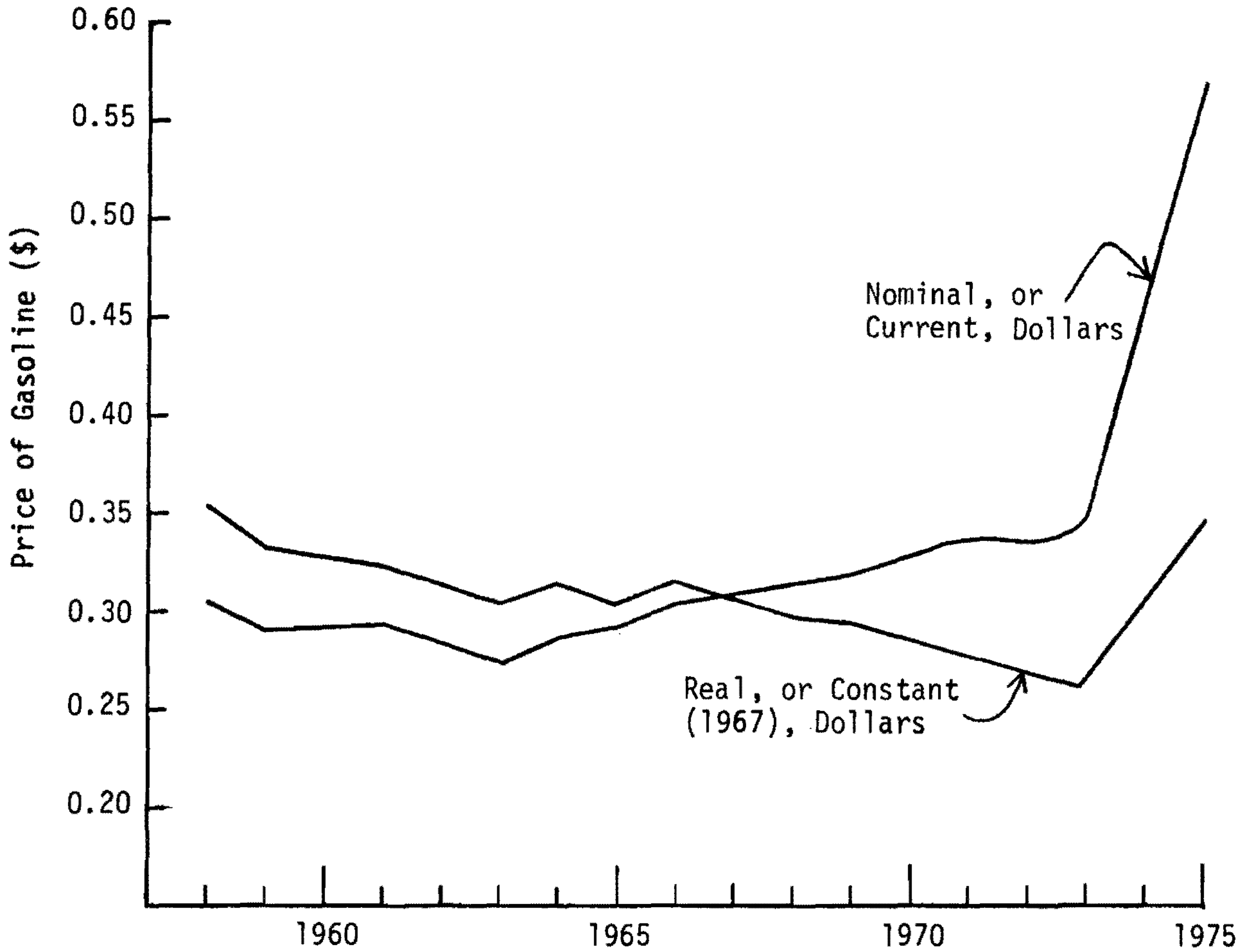

Figure 1. Real and Nominal Prices of Regular Gasoline, Including Taxes, for the Years 1958-1975

THE TEXAS TRANSPORTATION BILL: ESTIMATES AND ANALYSIS

ESTIMATES OF THE TEXAS TRANSPORTATION BILL

Estimates of the Texas transportation bill for the years 1959 through 1976 were made by TTI in order to facilitate an investigation of the relationship between transportation and the economy. For reasons mentioned earlier in the study, the bill estimates were made following as closely as possible the TAA methodology. Tables 1 and 2 present the current dollar estimates in a form similar to the TAA presentation of the national transportation bill in the publication Transportation Facts and Trends.

Table 1 includes the passenger bill and Table 2 contains the freight bill components of the total transportation expenditures in Texas (see the Apppendix 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 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 highway freight bill along with non-highway categories of rail, water, petroleum pipeline, air and other

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TEXAS PASSE ... ANSPORTATION BILL
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	1959	1960	1961	1962	1963	1964	1965	1966
Private Transportation								
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
Auto Repair	330.6	345.9	340.1	354.2	375.8	439.1	463.9	597.8
Gasoline	907.3	993.8	1,010.6	1,013.3	1,023.3	1,109.5	1,180.8	1,265.8
Registrations	55.8	58.0	59.9	63.1	66.1	69.1	72.5	75.7
Operators Licenses	3.0	3.4	3.9	5.8	9.5	10.8	10.1	6.6
Tolls	4.2	3.5	5.5	6.2	6.6	7.3	8.0	9.0
Fine and Penalties	9.2	11.1	10.7	11.6	12.7	3.2	20.5	21.4
Parking	4.5	4.1	4.0	3.9	3.6	3.5	3.4	3.3
Insurance	148.3	141.2	138.3	161.3	166.7	176.7	183.9	216.4
Interest	168.9	156.2	146.4	187.6	213.4	204.7	227.0	257.6
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
General Aviation	28.9	30.9	30.4	31.5	34.1	38.8	48.2	62.6
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
For Hire Transportation								
Bus, Taxi and Transit	98.8	101.3	99.2	102.2	101.0	105.5	107.8	112.1
School Bus	15.5	15.5	18.5	19.8	19.9	20.2	22.4	23.5
Rail	14.4	14.4	13.9	13.4	12.1	10.9	9.2	8.0
Air	162.3	175.5	179.1	192.5	208.0	240.1	272.4	260.2
Total For-Hire Transportation	291.0	306.7	310.7	327.9	341.0	376.7	411.8	403.8
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
Gross State 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
Grand Total as % of GTP	12.9	12.5	11.8	12.5	12.8	12.3	12.4	12.6

	7	1968	1969	1970	1971	1972	1973	1974	1975	1976
Private Transportation										
Auto										
New and Used Cars	59.8	$ 1,782.0	$ 2,118.4	$ 2,286.6	$ 2,314.1	$ 2,947.3	$ 3,474.8	$ 3,456.5	$ ---	$ ---
Auto Repair	33.7	604.6	687.2	778.0	882.1	994.5	1,106.3	1,244.4	---	---
Gasoline	40.8	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	78.6	89.1	94.8	98.7	103.9	110.0	117.2	120.8	---	---
Operators Licenses	6.0	10.4	11.6	5.5	9.0	8.9	10.8	11.4	---	---
Tolls	10.2	11.5	17.3	14.9	15.9	17.1	18.1	17.6	12.6	---
Fine and Penalties	23.0	23.4	25.9	25.7	27.2	29.2	32.3	35.0	---	---
Parking	3.4	3.4	3.7	5.8	5.3	5.0	7.2	8.2*	---	---
Insurance	48.5	245.0	258.8	290.5	391.7	429.7	349.2	354.0	---	---
Interest	64.0	267.3	317.8	343.0	347.1	442.1	521.2	518.5	---	---
Total Auto	68.0	4.477.2	5,071.9	5,580.6	5,958.7	6,982.9	7,839.8	8,492.6	9,309.4*	10,304.4*
General Aviation	61.4	68.1	81.0	103.6	119.0	119.4	144.8	178.7	184.3	251.2
Total Private Transport	29.4	4,545.3	5,152.9	5,684.2	6,077.7	7,102.3	7,983.6	8,671.3	9,493.7	10,555.6
For Hire Transportation										
Bus, Taxi and Transit	18.0	131.1	136.9	143.3	149.6	150.9	154.5	165.2	187.3	196.6*
School Bus	25.4	27.4	29.4	33.6	33.3	35.0	42.8	53.3	69.4	70.1*
Rail	6.1	5.9	3.1	2.5	2.8	3.0	3.0	4.7	4.2	4.5
Air	06.7	351.4	378.3	432.2	456.8	470.8	598.8	737.5	788.8	990.5*
Total For-Hire Transportation	56.2	515.8	547.7	611.6	642.5	659.7	799.1	960.7	1,049.7	1,261.7
Grand Total - private and for-hire	85.6	$ 5,061.1	$ 5,700.6	$ 6,295.8	$ 6,720.2	$ 7,762.0	$ 8,782.7	$ 9,632.0	$10,543.4	$11,817.3
Gross State Product	89.0	$44,213.0	$48,377.0	$51,465.0	$55,760.0	$62,437.0	$68,976.0	$72,440.0	$78,848.0**	$87,974.0**
Grand Total as % of GTP	11.9	11.4	11.7	12.2	12.1	12.4	12.7	13.3	13.4	13.4

* Preliminary Forecast

** Estimated

T 2

TEXAS FREIGHT ORTATION BILL

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	1959	1960	1961	1962	1963	1964	1965	1966		1968	1969	1970	1971	1972	1973	1974	1975	1976
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	5	$ 2,087.5	$ 2,005.3	$ 2,258.1	$ 2,594.6	$ 2,917.3	$ 3,218.5	$ 3,524.2	$ 3,896.1*	$ 4,347.0*
Truck-Local	815.8	827.5	931.2	960.0	1,213.1	1,278.6	1,466.2	1,525.9	9	1,795.0	1,960.3	2,222.7	2,602.1	3,109.4	3,535.8	3,688.2	3,998.3*	4,678.0*
Bus	1.4	1.5	1.7	1.9	2.1	2.3	2.6	2.8	1	3.6	4.0	4.5	4.6	4.9	5.0	5.3	5.2*	5.7*
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	5	3,886.1	3,969.6	4,485.3	5,201.3	6,032.6	6,759.3	7,217.7	7,824.8*	8,746.0*
Railroads	433.4	410.9	403.3	413.9	420.7	439.2	480.1	522.3	0	540.6	585.4	641.6	712.5	772.4	901.8	1,027.4	1,051.1	1,131.6
Water	291.2	301.0	306.7	313.4	324.7	333.2	341.9	355.1	7	348.7	357.3	396.0	414.6	444.4	579.1	722.1	758.2	960.6*
Oil Pipe Line	306.3	304.5	309.4	342.4	339.1	340.3	349.9	372.4	3	384.0	430.8	479.7	497.7	522.8	466.8	534.6	650.6	581.9*
Air	6.3	8.9	11.4	14.2	16.8	19.7	23.9	24.6	.2	34.3	33.2	35.8	42.7	59.4	56.5	58.0	70.4	63.5*
Other Shipper Costs	121.6	118.7	119.1	119.2	124.0	126.9	128.6	135.3	9	131.4	128.5	122.0	123.0	130.8	147.2	155.8	168.6*	187.0*
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	6	$ 5,325.1	$ 5,504.8	$ 6,160.4	$ 6,991.8	$ 7,962.4	$ 8,910.7	$ 9,715.6	$10,523.7	$11,673.6
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	0	$44,213.0	$48,377.0	$51,465.0	$55,760.0	$62,437.0	$68,976.0	$72,440.0	$78,848.0**	$87,974.0**
% GTP	13.9	13.4	13.4	13.1	13.5	13.4	13.1	12.9	.4	12.0	11.4	12.0	12.5	12.8	12.9	13.4	13.3	13.3

* Preliminary Forecast

** Estimated

shipper costs. Intercity truck, local truck and bus freight expenditures which comprise the highway bill are presented to facilitate analysis of individual highway modes. The "Other Shipper Costs" non-highway 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 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 represents 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 effect the Texas economy.

THE TEXAS TRANSPORTATION BILL AND GROSS TEXAS PRODUCT

An indication of the crucial role transportation plays in the Texas economy might best be illustrated in the relationship between the state's annual transportation bill and Gross Texas Product (GTP). Figure 2 shows the percent that the transportation bill for Texas composes of the gross state product for the years 1959 through 1976. (See Appendix B)

Although GTP has grown at an average rate of 3.9 percent over the long-run, the total transportation bill percent of GTP has remained relatively constant. Total transportation expenditures in the state have averaged approximately 25.2 percent of the gross product. Long-run stability in the transportation share of state output does not preclude apparent year-to-year fluctuations in the percentage of GTP. For example, slight declines in the total transportation percentage occurred in 1960 through 1962 and again in 1967 through 1969. The lowest transportation bill share of GTP over the entire study span occurred in the recession year of 1969 and was 2.1 percent below the long-run average share. A slight upward trend of the percentage since 1969 is also revealed in Figure 2.

General long-term consistency which characterizes the total transportation share of GTP does not appear in the passenger and freight component shares of the total transportation bill. Yearly passenger bills have averaged approximately 12.5 percent of GTP; however, the passenger bill has shown a significant increase in the long-run. A small rise above the 13 percent level has taken place in recent years; the peak year was 1976 with a 13.6 percent share of GTP. Again, as with the total bill, a slight decline in the passenger bill percentage took place in 1969.

The freight bill averaged almost 13 percent of GTP over the long run which is slightly higher than the passenger bill. The highest share was 14 percent in 1959. A major decline in the freight bill share of GTP lasted from 1967 through 1971. Comparison of the freight and passenger percentage declines during the downturn of economic activity reveals that the freight share dropped a little more than the passenger share.

The following basic points should be noted from the analysis of the transportation percentages of Gross Texas Product:

(1) the transportation bill constitutes a relatively constant share of GTP over the long-run,

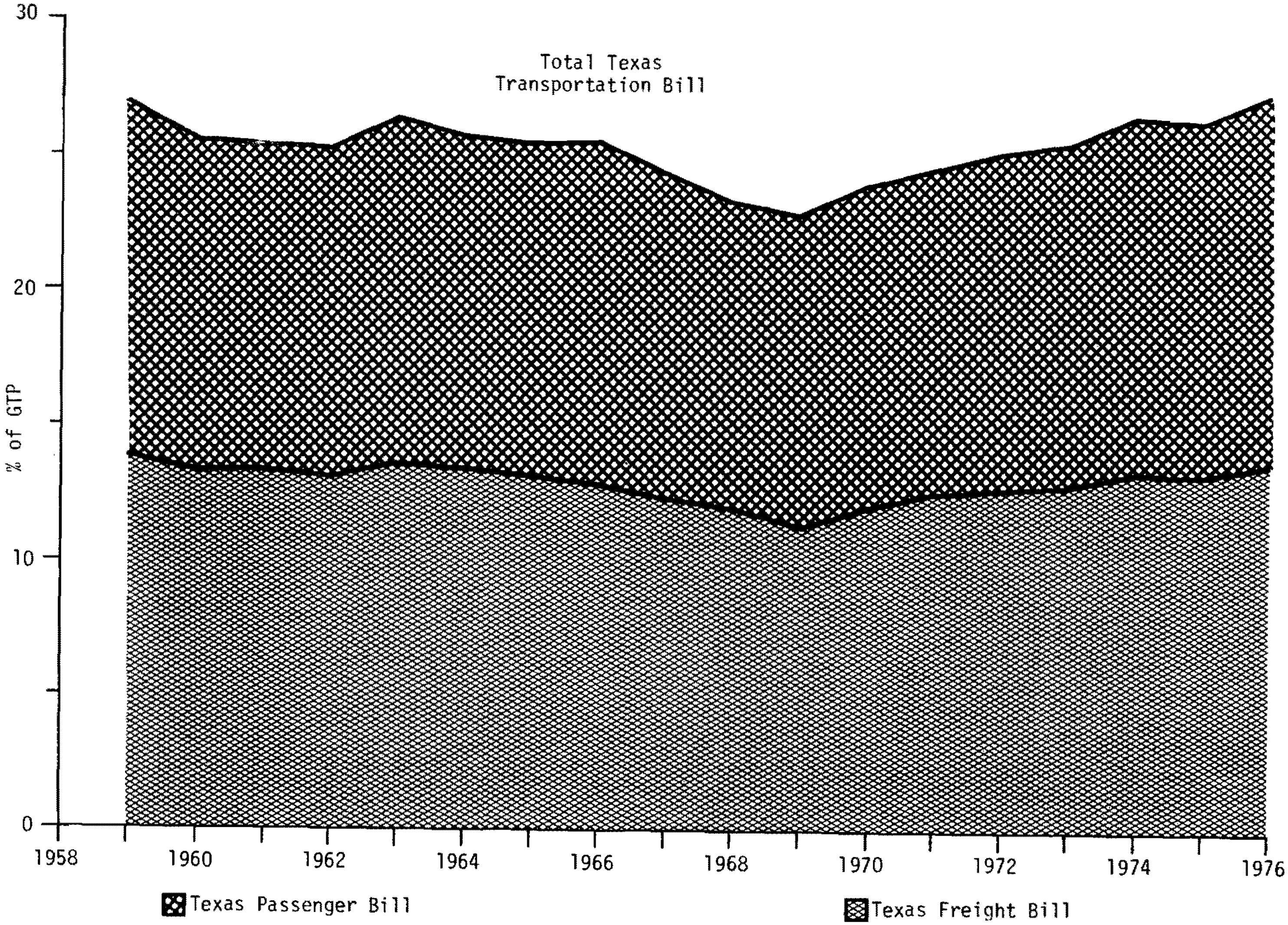
(2) short-run business fluctuations affect the total transportation share of GTP,

(3) a slight increase in the passenger bill share of GTP has occurred over time.

The long-run consistency of the total transportation bill percentage of GTP is evidence which supports the argument that the role transportation plays is crucial to the Texas economy. Certain levels of transportation expenditure seem necessary for the functioning of the economy and for economic growth.

FIGURE 2

TRANSPORTATION BILL FOR TEXAS AS A PERCENT OF GROSS OUTPUT
(1959 - 1976)



Short-run fluctuations of the transportation bill share over the business cycle also support the theory that a direct relationship exists between transportation and economic activity. The recessionary years of 1960-62 and 1968-70 in Figure 2 provide examples of downturns in economic activty accompanied by slight declines in transportation bill shares. While the recession years of 1968-70 provided the greatest share decrease, the severe recession year of 1974 did not produce a share decline (in fact, the transportation bill share of GTP actually increased slightly in 1974). There are three reasons underlying the severity of the recessionary share decreases during the sixties and the recessionary share consistency during 1974.

First, throughout the sixties, increasing amounts of foreign crude oil were imported through Texas ports and distributed to refineries located nearby. Although pipelines were probably used to transport the foreign crude, they were not used as extensively in the case of domestic crude transportation from Texas oil fields. As a result, GTP increased while pipeline revenue shares diminished. Although the quantity of imported oil increased throughout the sixties, it decreased drastically after the Arab oil embargo of 1973. This effect partially explains why pipeline revenue shares didn't decline in the 1974 recession.

Second, the U.S. balance of payments deficit and fixed exchange rates during the sixties made U.S. goods non-price competitive with foreign goods. For example, domestic agricultural products could not compete with foreign agricultural products during this period. Few domestic agricultural products were transported through Texas and exported from Texas ports. The increasing propensity for the state transportation bill to be largely dependent upon local and domestic markets increased the transportation sector's vulnerability to fluctuations in domestic business activity. When the business recessions occurred, as they did in 1960 to 1963 and again in 1968 through 1970, the transportation share of gross state product declined. After the U.S. dollar was allowed to float freely in the early 1970s, export activity increased and the Texas transportation sector share, in effect, became partially insulated from domestic business downturns. Additionally, Texas port and transportation activity may now actually increase the transportation share of GTP as domestic producers seek more lucrative foreign markets during economic downswings. This change in the economic activity and transportation share relationship may be shown by noting the percentage increases during 1974 in Figure 2.

The third reason for short-run transportation bill share fluctuations concerns the relationship between the Texas economy and the national economy. In the 1960-62 and 1968-70 recessions, the Texas economy was relatively insulated. As a result of the difference between state and national economic activity, the export of Texas products to other more depressed regions of the U.S. was reduced relatively more than Texas output declined. The long-haul transportation share of GTP fell during the recessions of the sixties. However, in the 1974 recession year, Texas GTP growth was affected as much as the growth of GNP. This mutual decline in economic activity resulted in a fairly constant transportation share of gross state product.

The three reasons are not the only explanations of short-run fluctuations in the transportation share of gross state output. Many other factors incidential to the expenditures on individual transportation modes probably account for the share changes. Further study to indicate the specific forces behind the share fluctuations is needed.

THE U.S. TRANSPORTATION BILL AND GNP

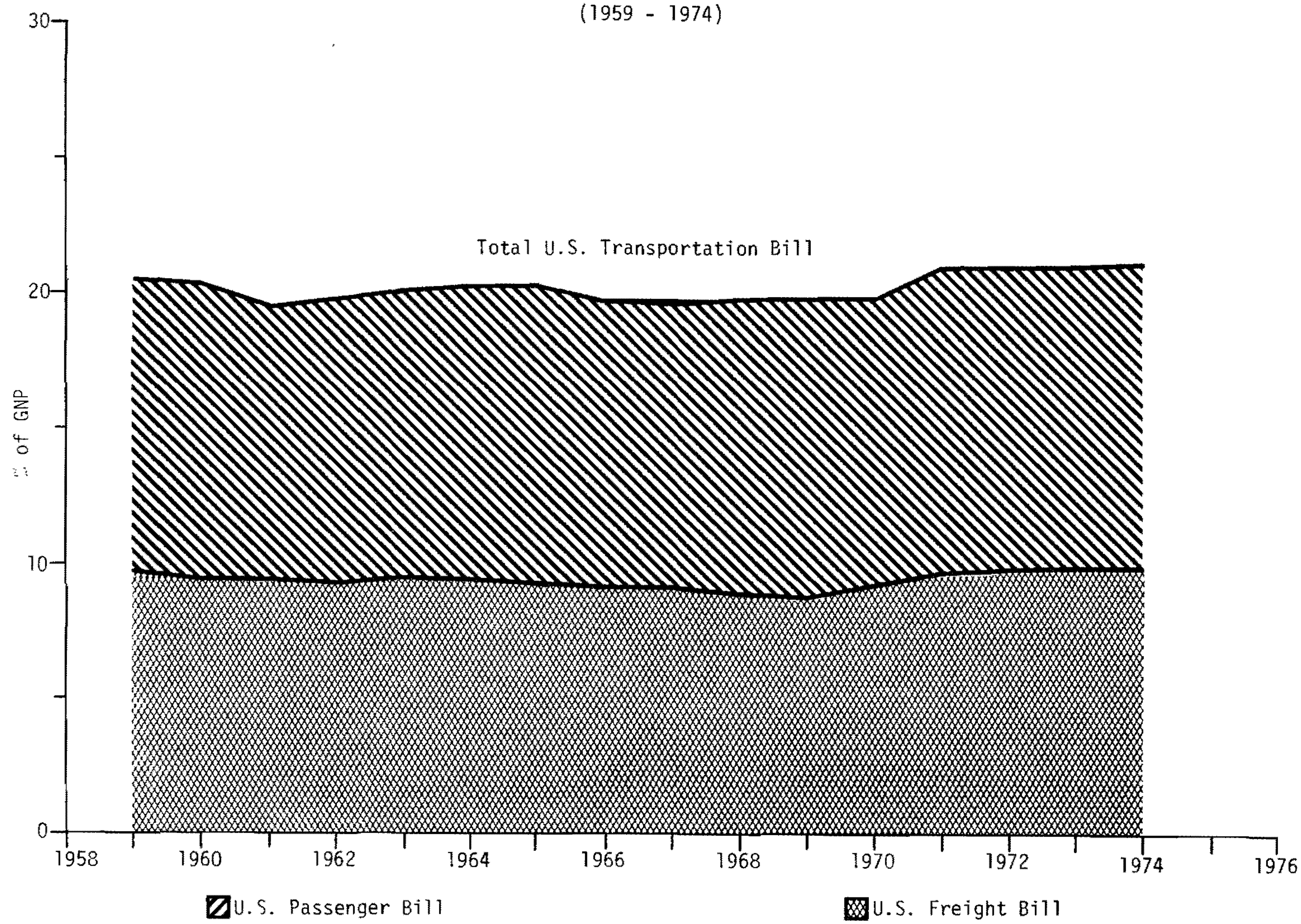
The same technique of determining the annual percent that the transportation bill represents of the gross product was applied to national data. Percentage trends for the years 1959 through 1974 are presented in Figure 3.

National total transportation bill percentages of GNP in Figure 3 illustrate that the transportation share of GNP is fairly constant in the long-run. This is reminiscent of the behavior of the state transportation bill shares of gross product. The total national bill represents approximately 20.3 percent of GNP, somewhat below the state bill average of 25.2 percent of GTP. Although both state and national transportation shares of gross product fluctuate in approximate accordance with the general level of economic activity, the business cycle seems to have a greater impact on the Texas transportation share of GTP. While the lowest national share decline was 0.8 percent below the average percentage of GNP, Texas percentages declined as far as 2.0 percent below the state average share of GTP. This implies that recessionary economic activity has greater impact on local transportation expenditures than national transportation expenditures.

As far as the components of the total national bill are concerned, both the U.S. passenger bill and the U.S. freight bill shares of GNP display a relatively constant relationship. In both subgroups, a slight upward trend is apparent in recent years. The U.S. passenger bill has averaged around 10.9 percent of GNP or about 1.7 percent below the state level average share of GTP. An analysis of the U.S. freight bill shares of GNP shows the national average is 3.6 percent below the Texas freight bill long-run or average share. This implies that most of the difference between state and national level bills is the freight transportation component. Thus, Texas is probably more freight transportation intensive than the nation.

Figure 3

TRANSPORTATION BILL FOR U.S. AS A PERCENT OF GROSS OUTPUT
(1959 - 1974)



The analysis of the comparison between Texas and U.S. transportation bill percentages of gross product reveals:

(1) Texas is more transportation intensive with regard to both passenger and freight bills;

(2) Texas transportation might be evolving from a freight intensive mix to a freight-passenger mix more closely resembling the nation;

(3) National transportation shares are less business cycle sensitive relative to state transportation shares.

The first point is strengthened further by inspection of Table 3. Texas annual transportation bills are a greater portion of U.S. annual transportation bills than Gross Texas Product is of Gross National Product. This is illustrated by comparing the total product row with the total transportation bill rows for each year in the table. The Texas transportation bill average share of the U.S. transportation bill is approximately 6.11 percent compared to the 5.05 percent GTP average share of GNP. This implies that more of Texas dollar expenditures are devoted to transportation than the portion of dollar expenditures spent for transportation in the U.S.

The state's freight bill share of the national freight bill has been fairly constant at approximately 6.90 percent for the sixteen years examined. A similar constant relationship between the state passenger bill share of the national passenger bill is also detected; the state passenger bill is approximately 5.46 percent of the national passenger bill. The state passenger bill share of the national passenger bill is slightly greater than the state's total product share for all years except 1968. The freight bill average share is 1.85 percent above the total product average share while the passenger bill average share is .41 percent above the total product average share. This reinforces the second proposition stated earlier; that Texas is more freight transportation intensive than the nation in general.

TABLE 3

TEXAS TRANSPORTATION BILLS AND TOTAL PRODUCT
AS PERCENT OF U.S. TOTALS FOR 1959 THROUGH 1974

	1959	1960	1961	1962	1963	1964	1965	1966
Passenger Bill	5.63%	5.36%	5.44%	5.54%	5.67%	5.24%	5.12%	5.44%
Freight Bill	7.02	6.93	7.04	6.78	6.93	6.90	6.87	6.98
Total Transportation Bill	6.27	6.07	6.19	6.11	6.25	5.99	5.89	6.12
Total Product	4.95	4.90	4.96	4.87	4.88	4.87	4.87	4.90

	1967	1968	1969	1970	1971	1972	1973	1974
Passenger Bill	5.42%	5.06%	5.25%	5.71%	5.30%	5.58%	5.72%	5.92%
Freight Bill	6.91	6.87	6.69	6.80	6.87	6.88	6.85	6.97
Total Transportation Bill	6.09	5.85	5.87	6.20	6.00	6.17	6.24	6.41
Total Product	5.03	5.09	5.17	5.24	5.24	5.33	5.28	5.15

Modal Shares of the Texas Transportation Bill

History is replete with examples of the decline in popularity of some means of transportation and the increase in the use of alternative means. For example, within the past twenty years, long-distance rail passenger service has been largely supplanted by air passenger service. While such factors as politics and technology influence the shift between transportation modes over time, economics also plays an important role in the shift to alternative transportation means. The importance of transportation is directly reflected in transportation usage and the importance of each mode may be implied from the mode's share of total usage.

A slightly broader concept closely related to the share of usage is the share of total transportation expenditures. An idea of the economic significance of each mode may be derived from the analysis of each respective mode's share of the total transportation bill. An analysis of the relative shares of various means of transportation is presented in this section. Expenditures in Texas on passenger and freight movement are expressed as percentages of the total transportation bill in Table 4. Modal shares under the general headings of passenger bill and freight bill are shown in the table.

The passenger bill segment of the total bill has increased slightly over the eighteen years included in the analysis. An approximate four percent annual passenger share increase lends support to the third proposition mentioned earlier--that Texas transportation is in a process of evolution with respect to the passenger-freight expenditure mix.

Two modes under the passenger bill category show evidence of growing relative shares of the entire bill. Automobile travel, one of the increasing

Table 4

Percentage Distribution of the Texas Total Transportation Bill for 1959 Through 1976

	1959	1960	1961	1962	1963	1964	1965	1966	1967
Passenger Bill									
Automobile	43.10%	43.12%	41.46%	43.79%	43.68%	42.57%	43.11%	44.42%	43.70%
Bus and Taxi	1.79	1.82	1.81	1.75	1.60	1.58	1.53	1.44	1.47
Air	2.99	3.23	3.22	3.21	3.20	3.50	3.75	3.44	3.77
Rail	.22	.23	.21	.19	.16	.14	.11	.09	.06
Total Passenger	48.10%	48.40%	46.70%	48.94%	48.64%	47.79%	48.50%	49.39%	49.00%
Freight Bill									
Highway	33.79%	33.73%	35.61%	33.83%	35.14%	36.40%	36.00%	35.60%	36.88%
Rail	6.77	6.42	6.20	5.94	5.57	5.52	5.62	5.56	5.11
Air	.10	.14	.18	.20	.22	.25	.28	.26	.30
Water	4.55	4.70	4.72	4.49	4.30	4.19	4.00	3.78	3.49
Oil Pipeline	4.79	4.76	4.76	4.90	4.49	4.27	4.10	3.97	3.88
Other	1.90	1.85	1.83	1.71	1.64	1.58	1.50	1.44	1.34
Total Freight	51.90%	51.60%	53.30%	51.06%	51.36%	52.21%	51.50%	50.61%	51.00%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	1968	1969	1970	1971	1972	1973	1974	1975	1976
Passenger Bill									
Automobile	43.11%	45.26%	44.80%	43.46%	44.41%	44.31%	43.89%	43.96%	44.00%
Bus and Taxi	1.52	1.48	1.42	1.33	1.18	1.11	1.13	1.21	1.12
Air	4.04	4.10	4.30	4.20	3.75	4.20	4.74	4.61	4.95
Rail	.06	.03	.02	.02	.02	.02	.02	.02	.02
Total Passenger	48.73%	50.87%	50.54%	49.01%	49.36%	49.64%	49.78%	49.80%	50.09%
Freight Bill									
Highway	37.41%	35.43%	36.01%	37.93%	38.36%	38.20%	37.31%	37.42%	37.73%
Rail	5.20	5.22	5.15	5.20	4.91	5.10	5.31	4.98	4.73
Air	.33	.30	.29	.31	.38	.32	.30	.33	.29
Water	3.36	3.19	3.18	3.02	2.83	3.27	3.73	3.59	3.73
Oil Pipeline	3.70	3.84	3.85	3.63	3.33	2.64	2.76	3.08	2.78
Other	1.27	1.15	.98	.90	.83	.83	.81	.80	.65
Total Freight	51.27%	49.13%	49.46%	50.99%	50.64%	50.36%	50.22%	50.20%	49.91%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

share modes, has grown approimxately two percent from 1959 to 1974. The slightly increasing long-run trend might be due to increases in the number of owner-operators and private sector shifts to greater multiple vehicle ownership. Additionally, increases in the average number of trips and the average number of trip miles per vehicle may account for the upward trend in auto travel transportation shares of the total bill. Higher real costs for automobiles along with higher real maintenance and operating costs also contribute to the increasing trend.

Although the long-run trend is increasing at a relatively stable rate, business fluctuations have a short-run influence upon the automobile bill share. The automobile yearly shares of the total transportation bill have fluctuated as much as 5 percent of the 1959 values. It is interesting to note that even after the higher gasoline prices percipitated by the energy crises in 1973 and 1974, there is still an upward trend in the relative share of automobile expenditures.

The second mode which shows an indication of an increasing relative share is the air passenger category. Both the commercial passenger service and the general aviation components of this bill have increased their portion of the total transportation bill. By 1976, the air passenger bill in Texas increased by approximately 65.5 percent from the 1959 relative share.

Rail passenger along with bus and taxi portions of the total bill in Texas declined over the period studied. Rail passenger shares dropped approximately 90.9 percent from 1959 to 1976 while bus and taxi shares declined approximately 37.4 percent over the same period. The magnitude of the bus and taxi decline is obscured due to the inclusion of school bus expenditures. School bus expenditures increased over the entire period covered by the study.

Several freight transportation modes registered declines in relative shares between 1959 and 1976. A 42 percent decline in the relative transportation bill portion of oil piplines occurred over the eighteen years studied. Rail and water transportation shares each declined approximately 30.1 percent and 18.0 percent, respectively. However, rail, water, and oil pipline transportation modes increased their relative shares immediately following the Arab oil embargo of 1973.

The highway freight percentage of the total bill, which includes local and intercity trucking along with bus freight, has increased 11.7 percent. Higher vehicle prices, fuel prices and wages account for much of the share increase. However, a part of the increase is due to a modal expenditure shift away from rail, water, and pipeline transportation to highway transportation. The highway freight relative share declined slightly, by about 2.3 percent, after the oil embargo. Higher fuel prices probably account, in part, for the decrease.

Although air freight represents a small portion of the Texas transportation bill, it almost doubled in its relative share from 1959 to 1976. Higher fuel prices and subsequently higher air freight rates might have contributed to the slight decline in the air freight share of the total transportation bill after the oil embargo.

In Table 5, the percentage distribution of the United States total transportation bills for 1959 through 1974 are presented. A comparison between Table 4 and Table 5 reveals differences in the state and national bill distributions. For example, the total passenger bill share for the nation is larger than the state passenger share by a series average of approximately 5.8 percent. This supports the proposition stated earlier that Texas

Table 5

Percentage Distribution of the United States Total Transportation Bill
for 1959 Through 1974

	1959	1960	1961	1962	1963	1964	1965	1966
Passenger Bill								
Automobile	46.29%	47.40%	45.59%	46.53%	46.38%	47.62%	48.76%	48.17%
Bus and Taxi	3.09	3.07	3.07	2.94	2.78	2.67	2.51	2.50
Air	3.21	3.37	3.54	3.61	36.8	3.65	3.92	4.32
Rail	.78	.72	.70	.63	.53	.47	.41	.38
Water	.28	.27	.24	.25	.27	.26	.24	.21
Total Passenger	53.63%	54.83%	53.14%	53.96%	53.64%	54.67%	55.84%	55.59%
Freight Bill								
Highway	31.09%	30.63%	32.65%	32.44%	33.14%	33.04%	32.23%	32.32%
Rail	9.15	8.56	8.28	7.85	7.55	7.12	6.84	6.77
Air	.32	.34	.39	.44	.43	.44	.48	.61
Water	3.24	3.17	3.06	2.95	2.96	2.59	2.59	2.74
Oil Pipeline	.87	.85	.87	.82	.81	.76	.73	.71
Other	1.70	1.63	1.61	1.54	1.48	1.38	1.29	1.26
Total Freight	46.37%	45.17%	46.86%	46.04%	46.36%	45.33%	44.16%	44.41%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	1967	1968	1969	1970	1971	1972	1973	1974
Passenger Bill								
Automobile	47.25%	48.44%	48.39%	46.45%	47.34%	46.64%	46.41%	45.49%
Bus and Taxi	2.55	2.56	2.53	2.55	2.38	2.20	2.07	2.10
Air	4.73	4.94	5.60	5.56	5.47	5.49	5.61	5.99
Rail	.32	.26	.24	.22	.16	.16	.16	.18
Water	.21	.14	.15	.14	.11	.11	.11	.09
Total Passenger	55.06%	56.34%	56.90%	54.92%	55.46%	54.60%	54.36%	53.85%
Freight Bill								
Highway	33.37%	32.66%	32.41%	34.46%	34.70%	36.12%	36.14%	36.03%
Rail	6.33	6.02	5.91	5.91	5.57	5.14	5.23	5.58
Air	.66	.62	.64	.58	.57	.58	.56	.58
Water	2.68	2.60	2.45	2.54	2.27	2.19	2.34	2.60
Oil Pipeline	.72	.68	.69	.70	.65	.62	.61	.62
Other	1.18	1.08	1.01	.89	.78	.75	.76	.74
Total Freight	44.94%	43.66%	43.10%	45.08%	44.54%	45.40%	45.64%	46.15%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

is more freight transportation intensive than the nation. Additionally, the difference between the state and national passenger bill shares has narrowed from 5.53 percent in 1959 to 4.07 percent in 1974. A reduction of the difference over time and the long-run stability of the U.S. passenger bill share lends support to the proposition that Texas may be evolving into a more passenger intensive transportation mix.

Most of the difference between the state and national passenger bill components lies in the automobile subcategory. The higher national automobile share may be the result of higher gasoline and maintenance costs in the nation relative to Texas. This does not mean that Texans use their automobiles less than the national average.

The national bus and taxi bill portion averages over fifty percent greater than the state bus and taxi share. Both the state and the nation have experienced declines in ths absolute shares of bus and taxi transportation over the long-run. The decline in taxi and bus percentages is probably due to decreases in ridership since the fall in the full cost of riding buses and taxis relative to the full cost of other passenger modes is unlikely. Full cost in this sense consists of money cost plus any other implicit personal costs.

Although air passenger bill shares for both the nation and the state grew between 1959 and 1974, the national share is greater. Due to fare regulation, this might indicate that Texas is less air travel intensive than the nation as a whole. Rail and water passenger travel represent such a small portion of the transportation bill they are omitted from the discussion.

The freight portion of the total state bill is greater than the national freight shares in three principle areas. Texas highway freight, water freight and oil pipeline bill percentages are larger than the national counterparts.

In 1974, the state oil pipeline share was six times the national percentage while the state water freight share was 1.43 times the national percentage. The Texas highway freight portion of the total bill was only slightly larger than the U.S. highway freight share. The state is neither air freight nor rail freight transportation expenditure intensive relative to the nation. U.S. air freight bill percentages of the total U.S. bill have historically been twice the state counterpart while U.S. railroad freight percentages are only slightly above the corresponding Texas percentages.

A comparison of the data in Table 4 and Table 5 reveals a similarity in the behavior of the state and nation transportation bill components. During the two recessions of the 1960s, both the U.S. and Texas experienced decreases in the total passenger relative to total freight shares. However, during the 1974 recession when the costs of fuels increased for both passenger and freight transportation, the passenger-freight relationship remained stable. Thus, the business cycle has a similar effect upon both state and national transportation sectors.

THE TEXAS TRANSPORTATION BILL IN CONSTANT DOLLARS

The transportation bill presented in Table 1 and 2 is adjusted by a price index (specifically the Purchasing Power of the Dollar Index) to obtain the bill in terms of 1967 dollar values. The adjusted or "constant dollar" Texas bill is displayed in Figures 4, 5, and 6 to illustrate the relative magnitude of modal contributions to the total bill and to show patterns of growth in the bill over time.

An examination of Figure 4 reveals that the Texas passenger bill has approximately doubled between 1959 and 1976. The largest component of the passenger bill--automobile transportation expenditures--also has approximately doubled in size over the same time span. Business cycle swings, which tend to be reflected in the total passenger bill, are largely derived from cyclical movements in automobile transportation expenditures. This relationship suggests that reductions in GTP and personal income are met by reductions in automobile transportation expenditures. Private automobile travel, therefore, is more sensitive than other passenger modes to the overall level of economic activity.

Commercial air passenger travel expenditures in the state have almost tripled between 1959 and 1976. The air passenger bill grew at an almost constant rate for most years except 1971 and 1972. Constant dollar expenditures in general aviation also have increased by almost 4.5 times over the eighteen-year study period. Although the magnitude of the state expenditures for school bus transportation is small relative to other passenger mode bills, the school bus bill has grown to 2.57 times its 1959 level. Intercity local bus, and taxi passenger expenditures did not grow between 1959 and 1976. The 1976 bus and taxi bill represents 99 percent of the 1959 expenditures in the same category. Rail passenger expenditures in Texas also declined over the long-run; however, a slight growth trend in the rail passenger bill occurred after the 1973 Arab oil embargo.

The Texas freight bill in constant dollars from 1959 through 1976 is shown in Figure 5. Unlike the total passenger bill, the freight bill did not double over the eighteen-year span of the study (the 1976 total freight bill represents 1.86 times the 1959 freight bill). Although the total freight bill did not double, highway freight, which represents the largest component of Texas freight transportation expenditures, more than doubled by 1976 (2.15 times the 1959 bill). In fact, highway freight expenditures grew faster over this period than the bills of most of the other freight transportation modes. Only the air freight bill grew more rapidly than the highway freight bill.

FIGURE 4

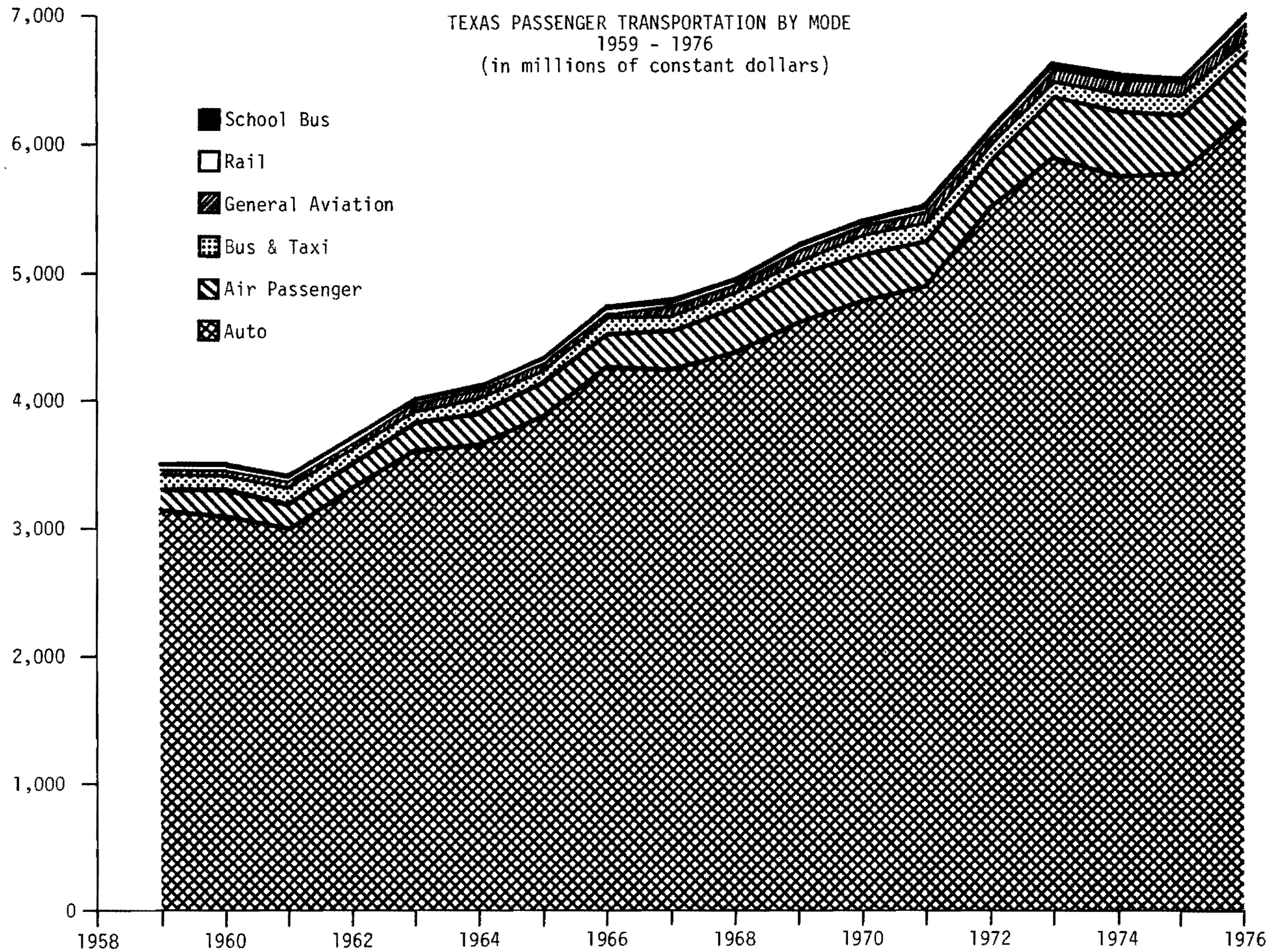
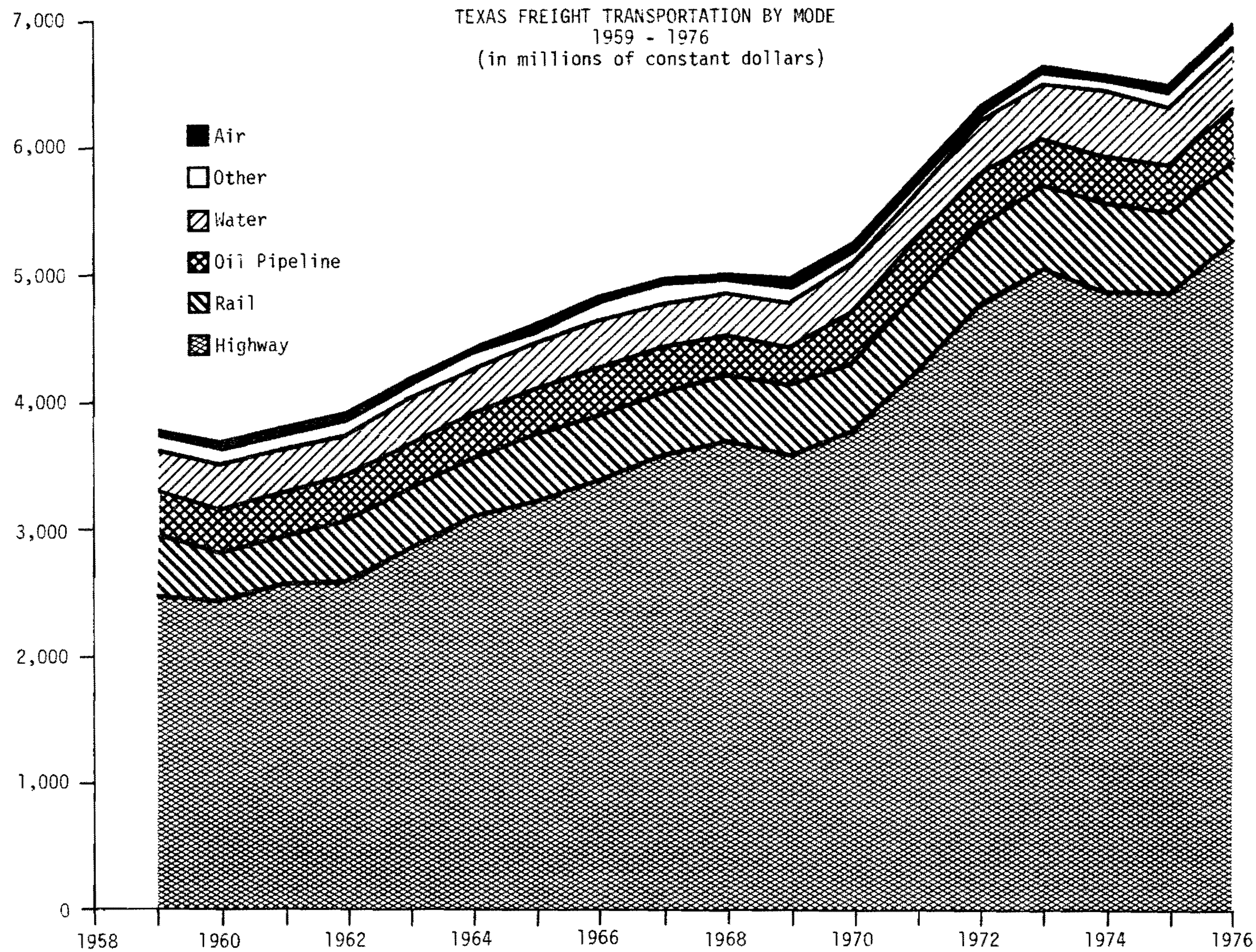

TEXAS PASSENGER TRANSPORTATION BY MODE
1959 - 1976
(in millions of constant dollars)
School Bus
Rail
General Aviation
Bus & Taxi
Air Passenger
Auto
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976

FIGURE 5



TEXAS FREIGHT TRANSPORTATION BY MODE
1959 - 1976
(in millions of constant dollars)
Air
Other
Water
Oil Pipeline
Rail
Highway
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976

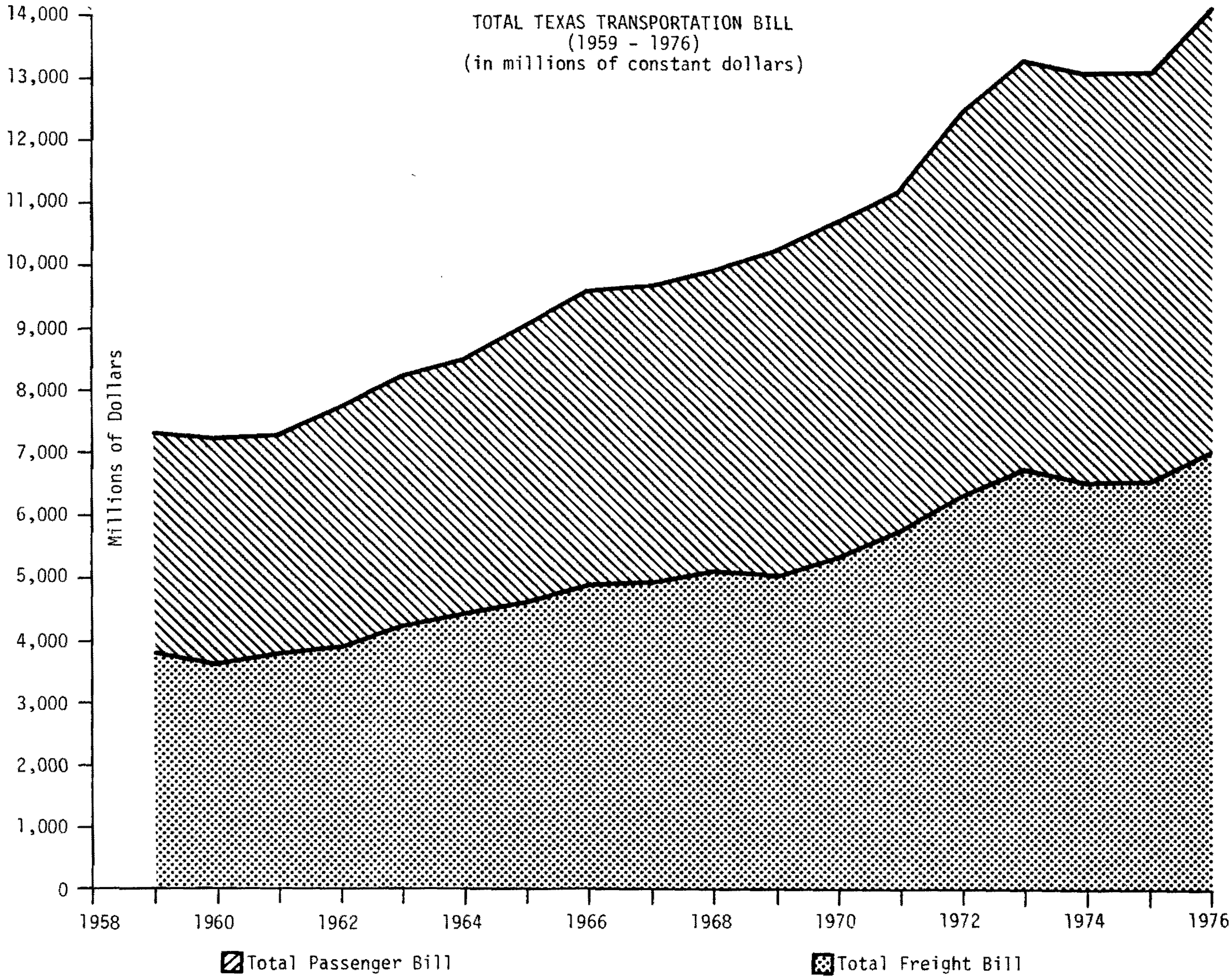
Highway freight transportation's largest competitor for intercity commodity traffic is rail freight. During the entire period studied, the constant dollar rail freight bill grew to 1.35 times its 1959 bill. From 1972 through 1974, rail freight expenditures in the state grew faster than they did in any other short-run period examined in this study. A large part of the rail freight bill growth might have been due to increased U.S. agricultural commodity export activity through Texas port facilities. For example, much of the grain for export to Russia and other foreign countries was carried by rail. Hence, the increase in rail transportation activity is reflected in the railroad freight bill. After, 1974, the constant dollar railroad freight bill declined. This coincides with a drop in U.S. bulk agricultural exports from Texas ports.

Freight transportation expenditures for water carriers remained relatively constant over the period from 1959 through 1971. After 1971, the increase in export activity also brought about greater expenditures for water transportation in Texas. Primarily as a result of the rapid growth in recent years, the long-run water freight bill by 1976 was 1.58 times the 1959 constant dollar level.

The oil pipeline bill in Texas has remained almost constant from 1959 through 1976. Figure 5 illustrates that the business cycle has little influence upon the magnitude of crude and refined product pipeline transportation expenditures. The 1976 pipeline bill represents only a 12 percent increase over the 1959 pipeline bill.

The sum of the passenger and the freight bills for each year are presented in Figure 6. The 1976 total bill represents 1.93 times the 1959 total bill while the 1976 total GTP represents only 1.90 times the 1959 total GTP. The growth in total transportation expenditures by the state's private sector was

FIGURE 6



TOTAL TEXAS TRANSPORTATION BILL
(1959 - 1976)
(in millions of constant dollars)
Millions of Dollars
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
Total Passenger Bill
Total Freight Bill

adversely affected by the 1960-62 and 1974-75 recessions, during which the total passenger and the total freight components of the entire Texas transportation bill were depressed. Although the years 1968 through 1970 were recessionary, the decline in the total freight bill was offset by growth in the total passenger bill.

In summary, the importance of private automobile transportation and highway freight transportation is shown by the relative magnitude of the auto bill and the highway freight bill to the total transportation bill. Together, these two modes account for almost 82 percent of all transportation expenditures in Texas. Most of the long-run growth in the Texas transportation bill is attributed to the tremendous growth in the automobile and highway freight mode bills. Additionally, automobile and highway freight expenditures in the state both are extremely sensitive to business cycle fluctuations. As a result, there is a very direct relationship between these two principal modes and the level of business activity in Texas. Economic growth in Texas is historically commensurate with growth in the private sector automobile passenger and highway freight bills.

PER CAPITA EXPENDITURES FOR TRANSPORTATION IN TEXAS AND THE U.S.

An analysis of the magnitude of the Texas transportation bill relative to (1) the size of the state's gross product and (2) the size of the national transportation bill helps gauge the signficance of transportation to the Texas economy. More can be learned, however, from the comparative analysis of the state and national bills if the data are "controlled" for the effects of population differences. Each of the bills thus far used in this study reflects the effects of three fundamental components:

(1) the cost of transportation per unit of service (e.g., the cost per passenger mile or the cost per ton mile),

(2) the population of the area in question,

(3) the degree of transportation utilization (e.g., the number of passenger-miles or ton-miles traveled.)

If assumptions are made with respect to the cost of transportation, and the population of the regions being studied (whether state or nation) are accounted for, then implications about the utilization of transportation obtain from the state and national bills.

The analysis presented in this section stops one step short of the exact determination of state and national transportation usage. The total transportation bills stated in constant dollar terms were adjusted to per capita terms by using population estimates for the years studied. This per capita transformation of the bills provides a better comparison of national transportation expenditure trends with those in Texas. In addition to permitting comparisons that are controlled for population size differences, the per capita relationship lend themselves to long-range forecasts. The per capita bill forecasting technique is a benefit that is discussed in the next section.

Time-series per capita bills by mode for both the nation and Texas are presented in this section. Each modal bill is in 1967 constant dollar terms in order to facilitate year-to-year comparisons. All subsequent references to bills or gross products concerns per capita values unless otherwise stated.

Per Capita Gross Products

A prefatory analysis of per capita gross products is presented before the analysis of per capita transportation bills. The comparison of the state and national per capita gross product will illustrate the relative trends in economic growth and the relative behavior of gross product data during the business cycle.

Per capita GNP and GTP both are shown in Figure 7. The most obvious feature in the two gross product time-series plots is the difference in the magnitude of state and national data. Gross Texas Product per capita is less than GNP per capita for all the years from 1959 through 1974. The difference between the state and national gross product has varied over the years. After the 1960 through 1961 recession, the gap widened and subsequently narrowed again later in 1964. Apparently, the state's recovery from the 1960 through 1961 recession was slower than overall national recovery. During the period of inflation, from 1965 though 1966, the gross product gap was relatively wide, although from 1966 through 1968 the gap narrowed a bit. The narrowing from 1966 through 1968 was probably due to increased Federal expenditures in Texas with respect to: (1) the Viet Nam War escalation, (2) the space program, (3) the anti-poverty program. Texas probably benefited more from the first two Federal expenditure activities than from the third activity mentioned [6]. Additionally, a severe credit crunch hit the U.S. in 1966 and 1967 which could have had a relatively less significant impact upon the Texas economy. The

1968-70 recession did not retard Texas' per capita gross product growth as much as the growth in per capita GNP was diminished. As a result, the gross product gap narrowed during the severe recession of the latter sixties. An inflationary period which followed the 1968-70 recession was accompanied by a widening of the gross product gap. The gross product gap remained relatively wide until the 1973 Arab oil embargo after which a small narrowing of the gap occurred. An abundance of petroleum products in Texas might have contributed to the 1973 increase in per capita GTP that was much greater than the relative increase in per capita GNP. Also, in 1972 and 1973, prices for agricultural products rose due to a world food supply shortage. Since agriculture plays an important role in the Texas economy, the increase in world food prices during this period may have contributed to a smaller gross product gap. An analysis of Figure 7 supports that statement made earlier in this study with regard to the relative insulation of the Texas economy during the 1968-70 recession and the comparatively greater severity of the 1974-75 recession upon the Texas economy. Over the long-run, the general trend of Texas gross product growth is similar to the growth trend of GNP [6].

The following three major points stand out in a summary of the above analysis:

(1) per capita GTP has historically been lower than per capita GNP;

(2) per capita GTP and per capita GNP both have similar trends of long-run growth;

(3) some specific Texas characteristics exist which cause short-run per capita GTP behavior to differ from the short-run behavior of per capita GNP.

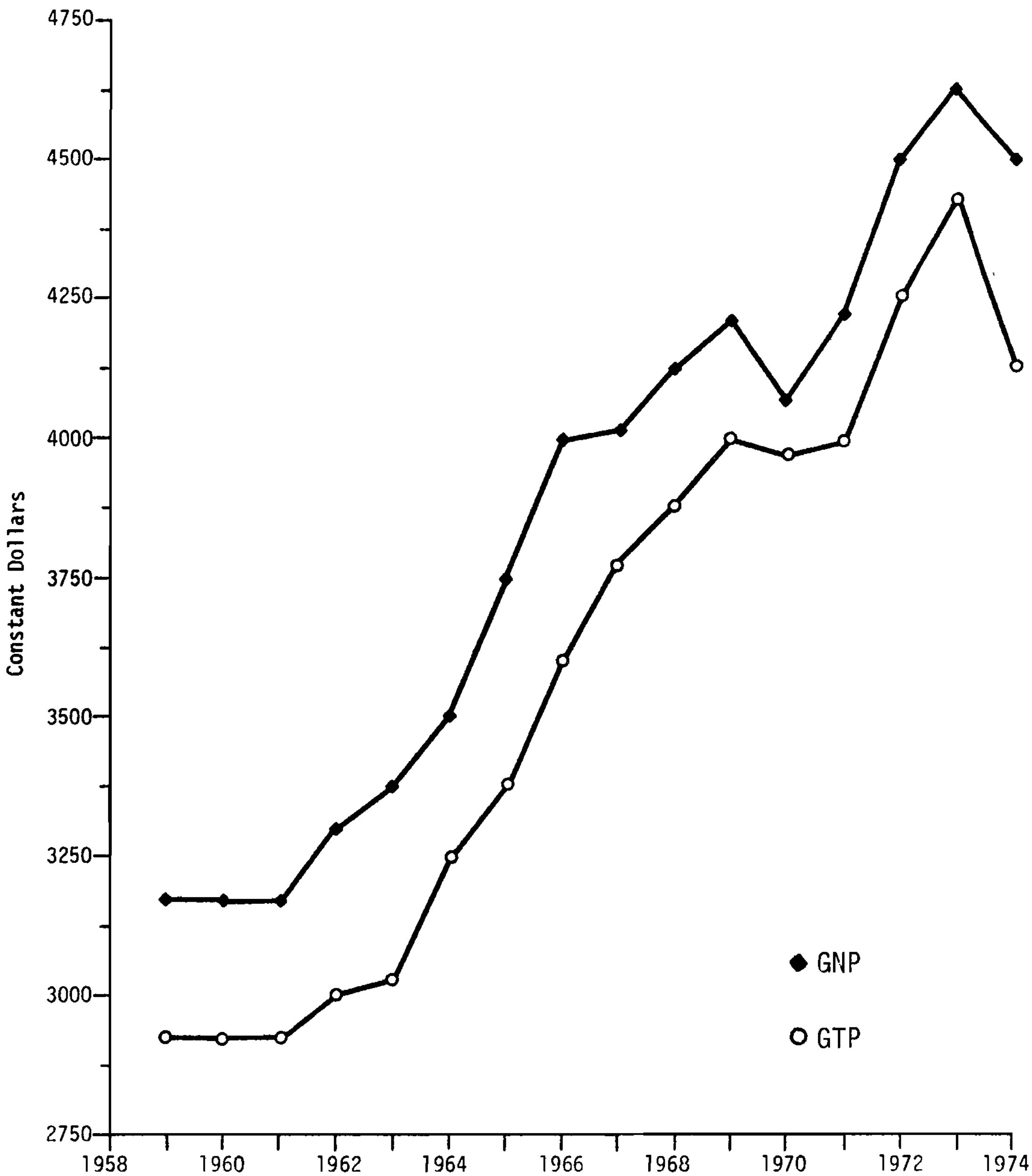


Figure 7. GNP and GTP Per Capita
(in constant dollars)

The Texas Passenger Bill Per Capita

The Texas per capita passenger bills and the U.S. per capita passenger bills for the years 1959 through 1976 are shown in Figure 8. In the long run, the magnitude of the state per capita passenger expenditures are approximately the same as those nationally. The similarity in the size of the state and national per capita expenditures together with smaller per capita GTP relative to per capita GNP implies that in Texas, out of each dollar of gross product, more is spent for passenger transportation than is spent for passenger transportation in the U.S. The state and the national transportation bills per capita both have about the same long-run growth trend. Such similarity in the per capita gross product trends coupled with the similarity in the passenger bill trends supports the proposition that there is a specific and direct relationship between passenger transportation expenditures and the level of overall economic activity. Additionally, and in conjunction with Figure 7, Figure 8 illustrates that passenger expenditures for Texas and the U.S. both are highly related to gross product in the short-run. The same general cyclical swings affect the total passenger bill and the total gross product as well. Two examples, which demonstrate the close relationship between economic activity and the passenger bills are the gross product and passenger bills during: (1) the "credit crunch" of 1966-67, and (2) the 1970 recession. The credit crunch of 1966 and 1967 slowed per capita GNP growth more than the tight credit period slowed per capita GTP growth as illustrated in Figure 7. In Figure 8, for the same years, per capita national passenger expenditures dipped below Texas' per capita passenger expenditures. Again, comparing Figure 7 with Figure 8 shows that 1970 per capita GNP declined much more than per capita GTP while at the same time U.S. per capita passenger expenditures fell below the Texas per capita passenger expenditures.

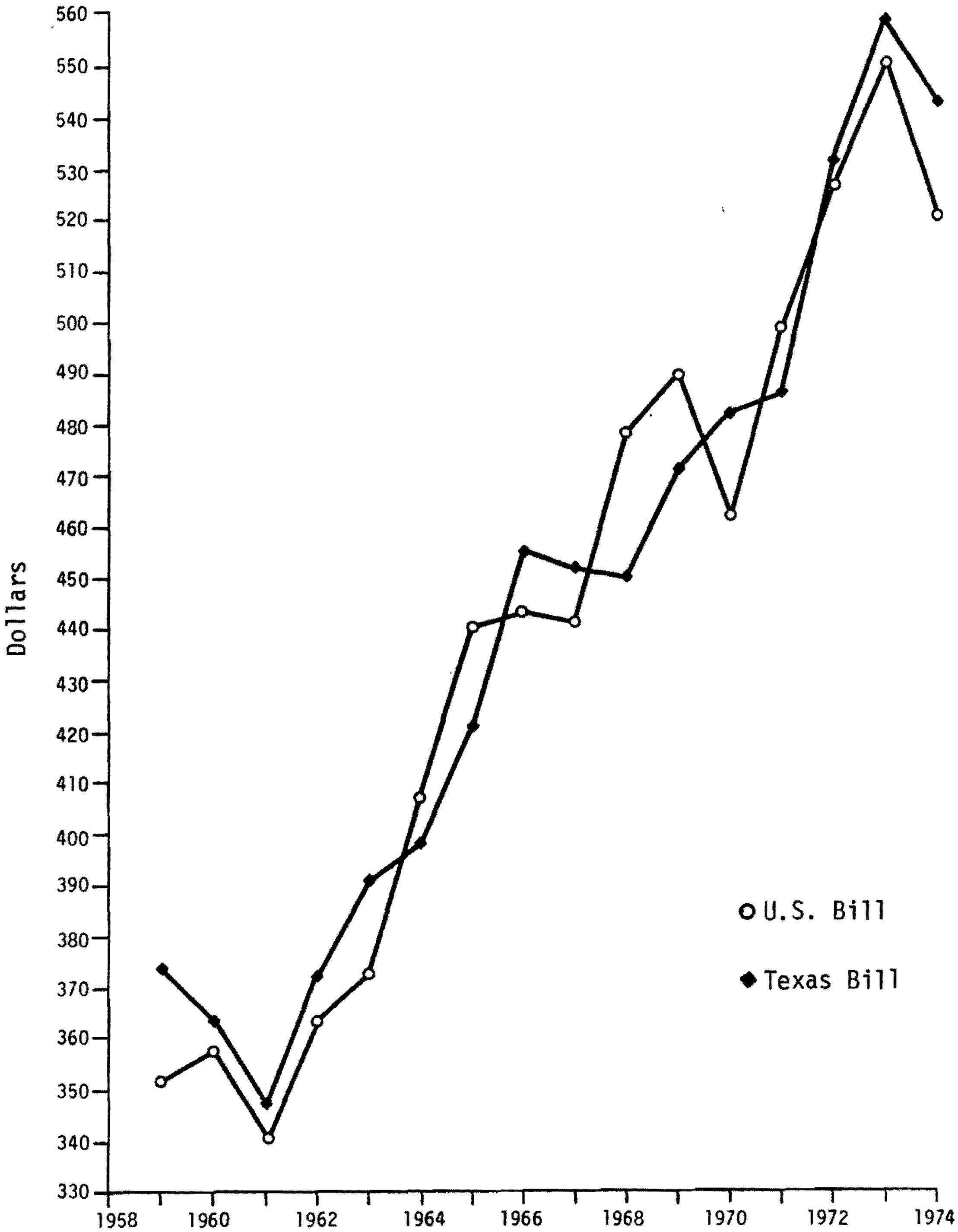


Figure 8. U.S. and Texas Total Passenger Bills Per Capita (in constant dollars)

The per capita modal bills, which compose the total passenger bill, are helpful in revealing how much each means of transportation contributes to the long-run trends and short-run fluctuations of the total passenger expenditures for transportation. Additionally, an analysis of the modal bills might identify any economic conditions contributing to the similarities and differences between the state and national passenger bills. The modal bills per capita also have an appeal for less analytical purposes, for they indicate approximately how much each person (on the average) in Texas has spent annually for passenger transportation. More precisely, however, the modal bills show the passenger expenditure allocation per individual on the average and not the expenditure allocation of the average individual.

THE AUTO BILL PER CAPITA

The long-run growth pattern of the Texas auto bill shows the 1974 bill to be 1.43 times the 1959 bill while the U.S. per capita bill increased to about 1.44 times the 1959 U.S. bill level. This similarity in Texas and U.S. auto bill growth trends is shown in Figure 9.

Since automobile transportation expenditures represent approximately 89 percent of the state's total passenger transportation bill, the automobile bill should be largely responsible for: (1) the long-run growth trend of the passenger bill, and (2) the short-run fluctuations in the passenger bill. A comparison of the auto bill in Figure 9 with the total passenger bill in Figure 8 illustrates these points. The same basic trend of long-run growth holds for both the auto bill and the total passenger bill. In addition, the year-to-year fluctuations of the auto bill correspond to fluctuations found in the total passenger bill. These long-run and short-run similarities in auto bill to passenger bill relationships apply to the U.S. as well as to Texas.

A comparison of the U.S. auto bills with the state's auto bills in Figure 9 discloses that the Texas per capita bill lies below the national bill on only two occasions, 1965 and 1968. In 1965, the U.S. per capita auto expenditures might have risen faster than the Texas per capita auto expenditures because of the difference between the Texas economy and national economy responses to a tax reduction passed by Congress in 1974. Also, as shown in Figure 8, the per capita gross product of Texas grew at a slower rate than the growth of U.S. per capita GNP from 1964 through 1965. The nationwide "credit crunch" of 1966-67 together with the relatively slow subsequent Texas economic recovery could be the reason for the 1968 rise in the U.S. auto bill above the state's auto bill. In general, the Texas per capita expenditures for auto transportation exceed the U.S. per capita expenditures for auto transportation.

A reason for the intensiveness of the state's passenger transportation relative to U.S. passenger transportation is the level of automobile-related expenditures. If an assumption is made with respect to the relative costs of U.S. automobile transportation and Texas automobile travel, then conclusions may be reached about the intensity of automobile usage in Texas. For example, if the costs of automobiles and automobile operations in Texas and the U.S. are assumed to be equal, then per capita usage of auto travel is greater in Texas than the U.S. However, usage of auto travel is defined in broad terms and is composed of the number of new and used cars purchased in a given year along with the number of miles driven. Further study is needed to determine the relative U.S. and Texas constant dollar components of the auto bill and to disclose the relative Texas and U.S. per capita number of cars annually purchased along with per capita passenger miles driven. Any such study must

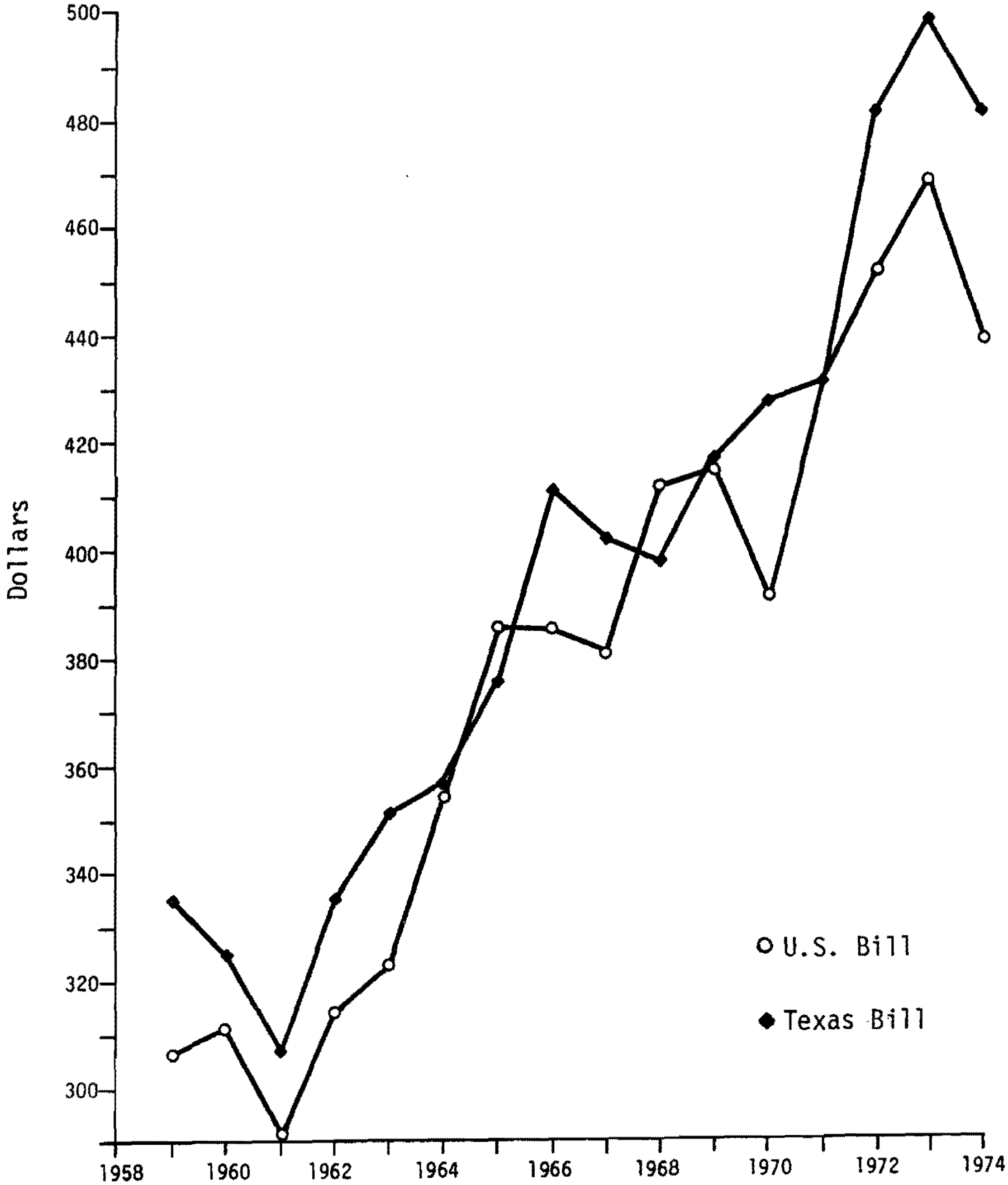


Figure 9. U.S. and Texas Auto Bills Per Capita
(in constant dollars)

be framed with assumptions concerning relative U.S. and Texas auto costs and auto operating costs along with fleet gasoline mileage.

As with the per capita passenger bill, the auto bill occasionally moves in the opposite direction of fluctuations in gross product. This phenomenon might be the result of a link between automobile sales and the availability of consumer credit [7]. In the tight money years 1966-67, money that was previously available for automobile loans became scarce; subsequently, auto sales in the nation declined [8]. Tight credit conditions in the state might have lagged the nation causing depressed auto expenditures in Texas to occur in 1967 and 1968 instead of 1966 and 1967. In 1970, when interest rates in the nation soared upward, automobile sales in the U.S. plummeted [8]. Credit for auto loans in Texas during 1970 might not have been as tight as credit in the U.S. as a whole. This less restrictive Texas credit situation was more likely due to the less severe impact that the 1968 through 1970 recession had upon the Texas economy. The greater availability of credit in Texas partially explains the short-run differences between the U.S. and the Texas auto bills.

Another reason for the difference in U.S. and Texas auto bills lies in the factors which contribute to automobile transportation cost differentials. For example, increases in the Texas price of gasoline relative to the U.S. price of gasoline along with the constant relative state-to-nation usage of gasoline will cause the Texas auto bill to rise relative to the U.S. auto bill. Any of the components of the auto bill are potential contributors to differences between the U.S. and Texas bills.

THE BUS, TAXI, AND TRANSIT BILL PER CAPITA

Expenditures in both Texas and the U.S. on bus, taxi and transit passenger service declined somewhat dramatically between 1959 and 1974 as shown in Figure 10. A net 3.02 dollar per capita U.S. bill decline and a net 2.71 dollar per capita Texas decline occurred over the 16-year period studied. Note that the decline continued unabated during the years of the Arab oil embargo and the subsequent energy crisis.

An obvious distinction between the Texas and national per capita bus, taxi and transit bills is the extreme difference in the magnitude of bills. Over the long-run approximately five dollars less per capita is spent in Texas than in the U.S. for bus and taxi service. The five dollar difference amounts to about 34 percent of the 1974 per capita expenditure in the U.S.

THE SCHOOL BUS BILL PER CAPITA

The per capita expenditures for the transportation of school children in Texas and the U.S. are plotted in Figure 11. Expenditures in the U.S. for busing school children have increased at a fairly constant rate from 1959 through 1974. Texas per capita expenditures are much lower than the U.S. per capita expenditure and the state's bill has grown at a slower rate over the long-run than the growth rate of the national bill. However, from 1972 through 1974, the Texas school bus bill grew at approximately the same rate as the national growth. Until 1972, the gap between the U.S. per capita school bus bill and the Texas bus bill widened. In 1959, slightly over 1.06 dollars more were spent per U.S. citizen than per Texas citizen for school bus transportation. By 1974, Texans were paying 1.59 times as much as they were for school bus transportation in 1959 while U.S. citizens as a whole were paying 2.01 times their 1959 school bus expenditure.

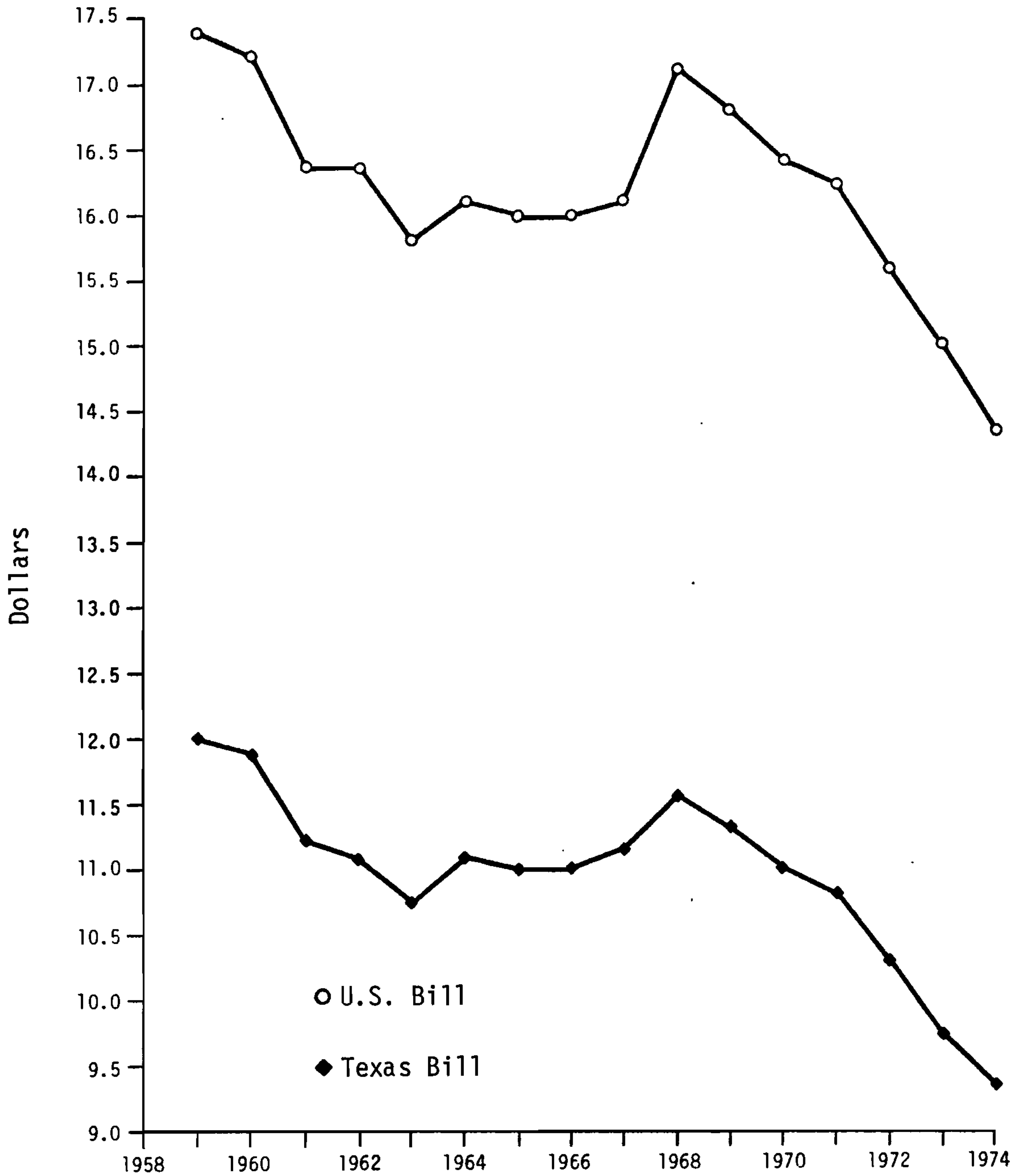


Figure 10. U.S. and Texas Bus, Taxi and Transit Bills Per Capita (in constant dollars)

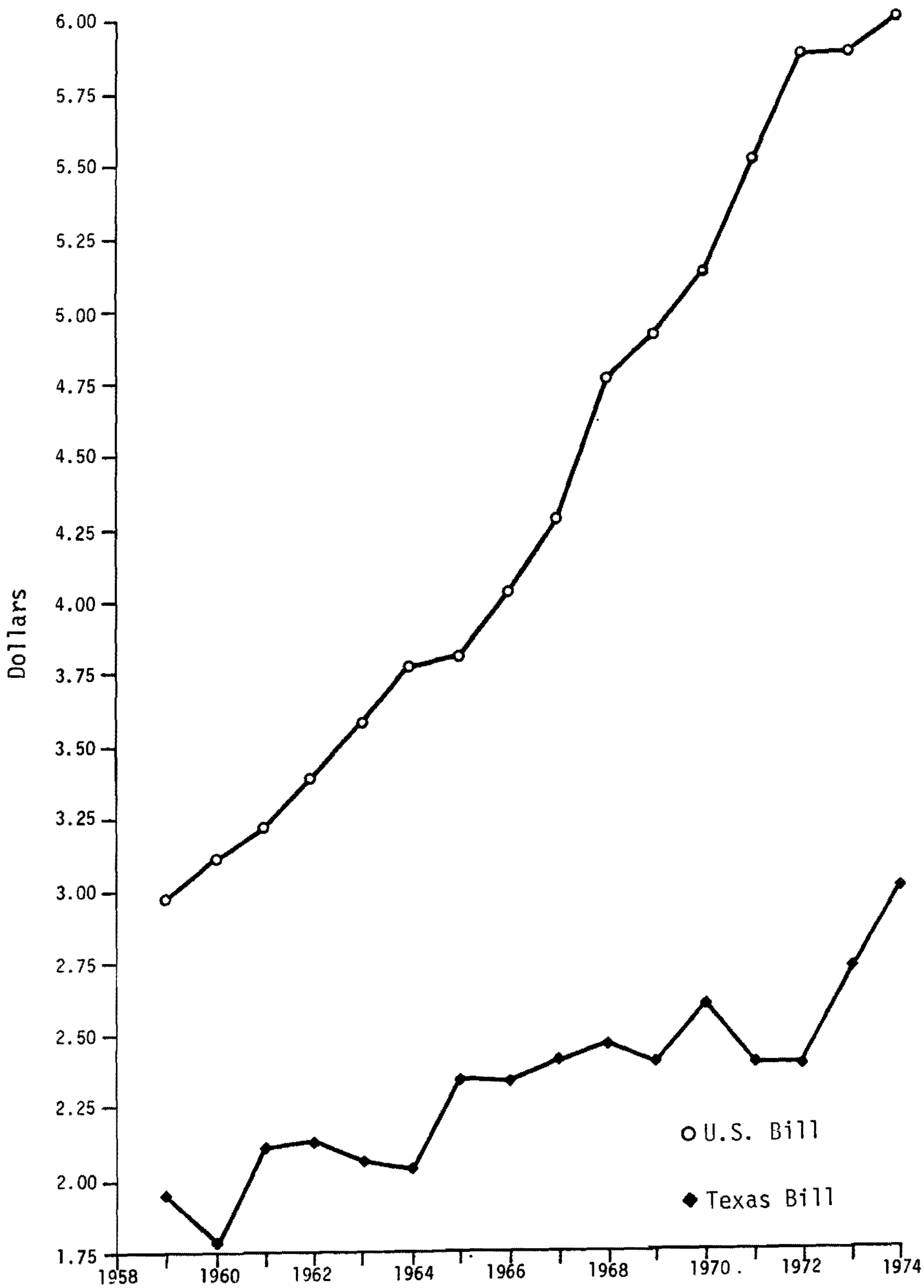


Figure 11. U.S. and Texas School Bus Bills Per Capita (in constant dollars)

THE RAIL PASSENGER BILL PER CAPITA

Rail passenger expenditures in Texas are exceedingly small and are well below U.S. expenditures as shown in Figure 12. In 1959, only 1.75 dollars were spent per capita in Texas compared to almost 5.0 dollars spent per capita in the U.S. The 1974 per capita expenditures for rail passenger service fell to 27 cents in Texas versus 1.72 dollars spent in the U.S. the same year.

A year after the creation of the National Railroad Passenger Corporation (commonly known as AMTRAK) in 1970, rail passenger expenditures per capita slowly grew in the nation [9]. Texas per capita expenditures, however, became relatively stable at about 25 to 27 cents per year after the inception of the AMTRAK service.

THE AIR PASSENGER BILL PER CAPITA

The rapid growth of expenditures in Texas and the U.S. for passenger transportation over regulated air carriers is illustrated in Figure 13. Texas expenditures per capita are approximately the same as per capita national expenditures for air passenger service. Since Texas' per capita output is less than U.S. per capita output, Texas may be generally viewed as air passenger transportation intensive relative to the nation. A slight difference in the long-run growth trend of state and national expenditures is apparent. Before 1967, the air passenger bill (as shown in Figure 13) was greater in Texas than the U.S.; however, after 1967 and through 1974, the U.S. air passenger expenditures per person exceeded the Texas air passenger per capita expenditures. This suggests that in the long term, the state's bill is not growing as fast as the national bill. The Texas air passenger bill per capita in 1974 was 2.10 times the 1959 level while the U.S. air passenger bill per capita in 1974 was 2.82 times the 1959 level.

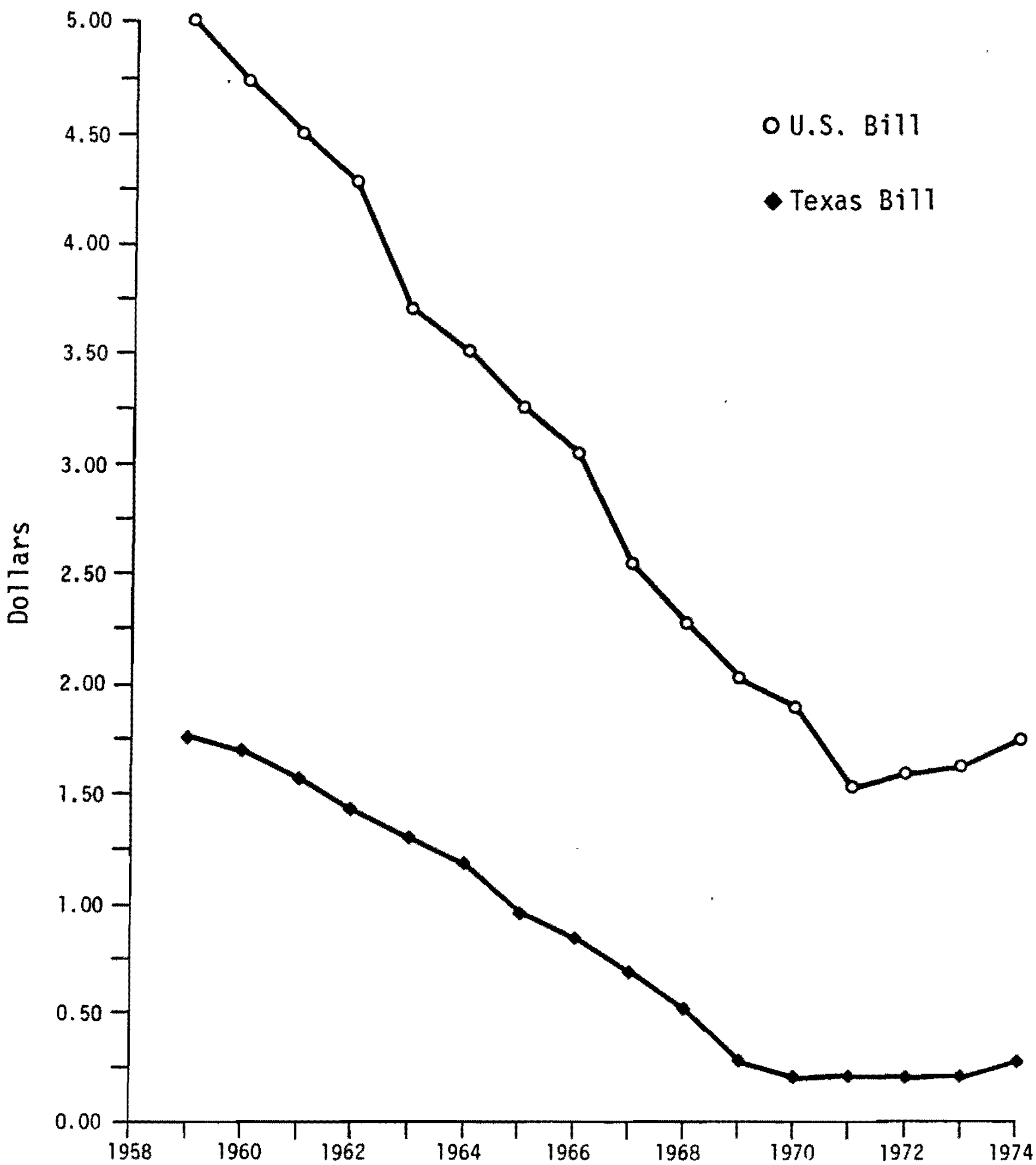


Figure 12. U.S. and Texas Railroad Passenger Bills Per Capita (in constant dollars)

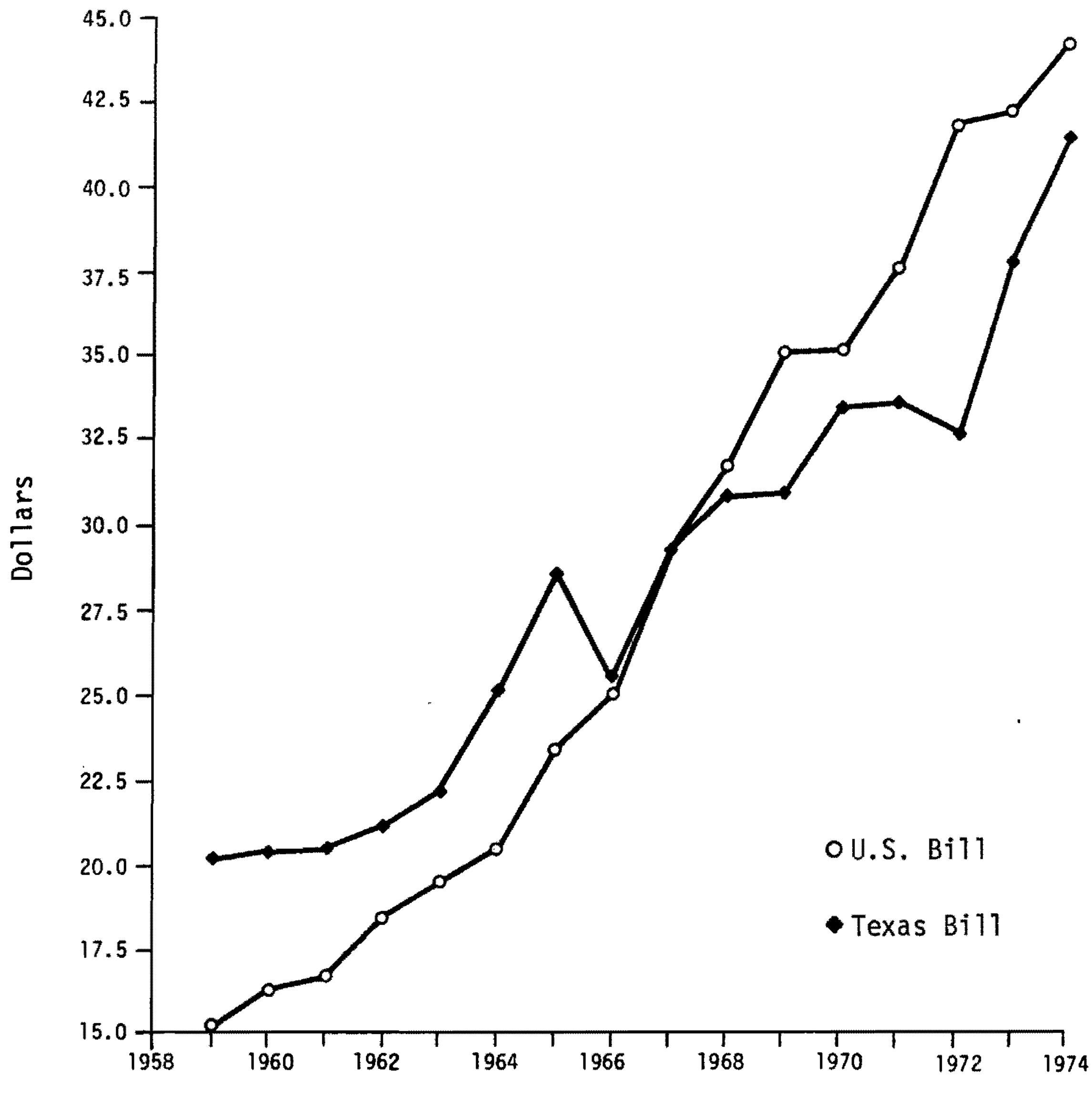


Figure 13. U.S. and Texas Air Passenger Bills Per Capita
(in constant dollars)

THE GENERAL AVIATION BILL PER CAPITA

Texas expenditures per person on general aviation from 1959 through 1974 have consistently been less than national expenditures per capita. Figure 14 illustrates that although the national bill is greater than the Texas bill, the national and the Texas general aviation bills both have approximately the same growth trend. Between 1959 and 1974, the U.S. expenditures per person have grown approximately 8.11 dollars while Texas expenditures per person have grown 6.49 dollars.

THE TEXAS FREIGHT BILL PER CAPITA

The Texas freight bill per capita and the U.S. freight bill per capita for the years 1959-1974 are shown in Figure 15. The most obvious difference between the two bill series is that the Texas bill lies above the U.S. bill for each year. Over the long-run, the yearly Texas bill per person has averaged 90.81 dollars greater than the U.S. bill per capita. A greater per capita freight bill in Texas together with lower per capita GTP relative to per capita GNP implies that Texas is freight transportation intensive. This means that out of every dollar of gross output, a larger portion is spent on the movement of freight in Texas than is spent on freight movement in the U.S. in general.

If the cost of freight transportation per ton-mile is assumed to be equal or less than the freight cost per ton-mile in the U.S. as a whole, then Texas may be considered intensive in the usage of freight transportation. Intensive usage means that the Texas freight transportation industry either generates more ton-miles or uses more equipment (or both) for each unit of state gross output than the U.S. freight transportation industry in general. The crucial role of transportation in Texas then becomes very apparent. The

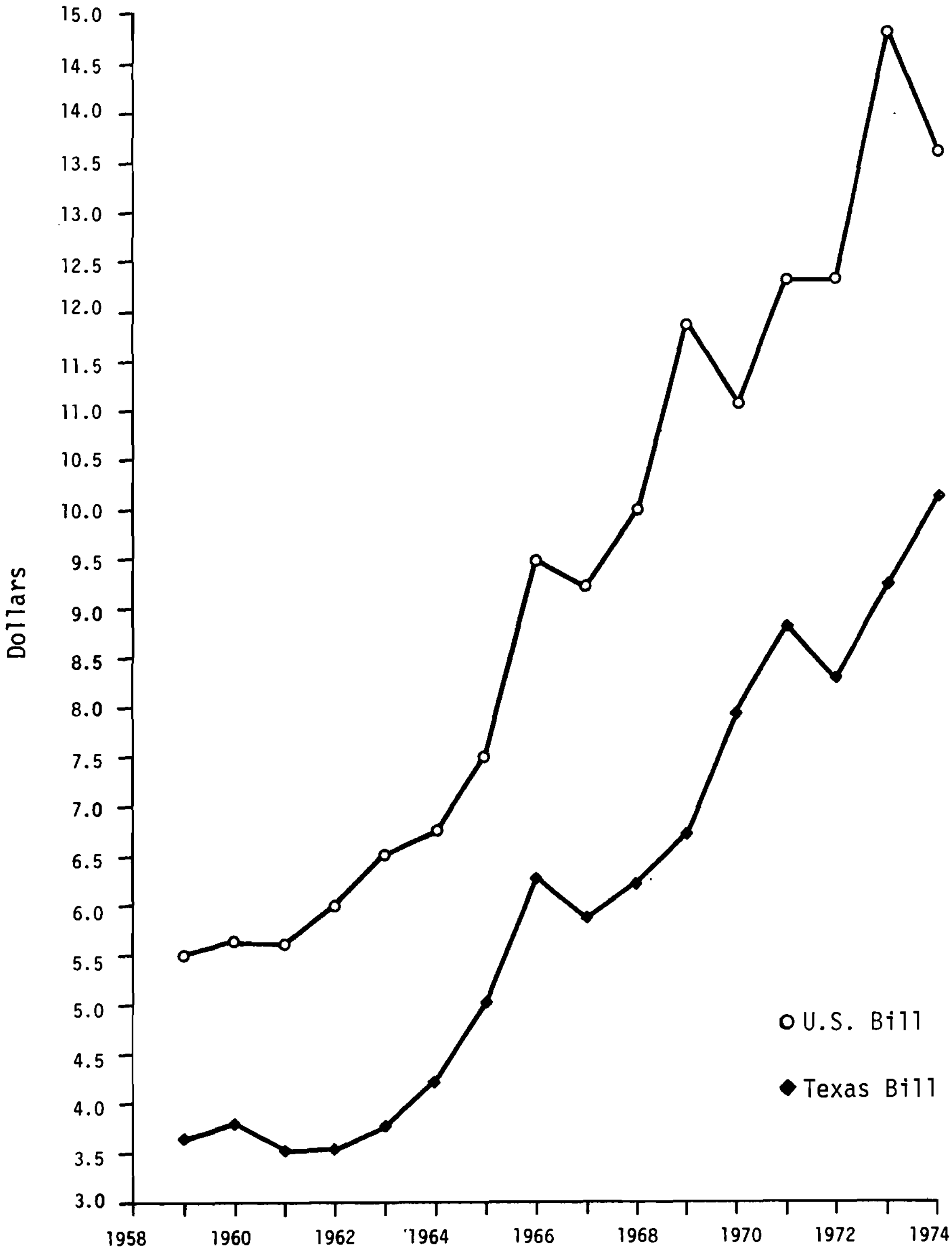


Figure 14. General Aviation Bills Per Capita
(in constant dollars)

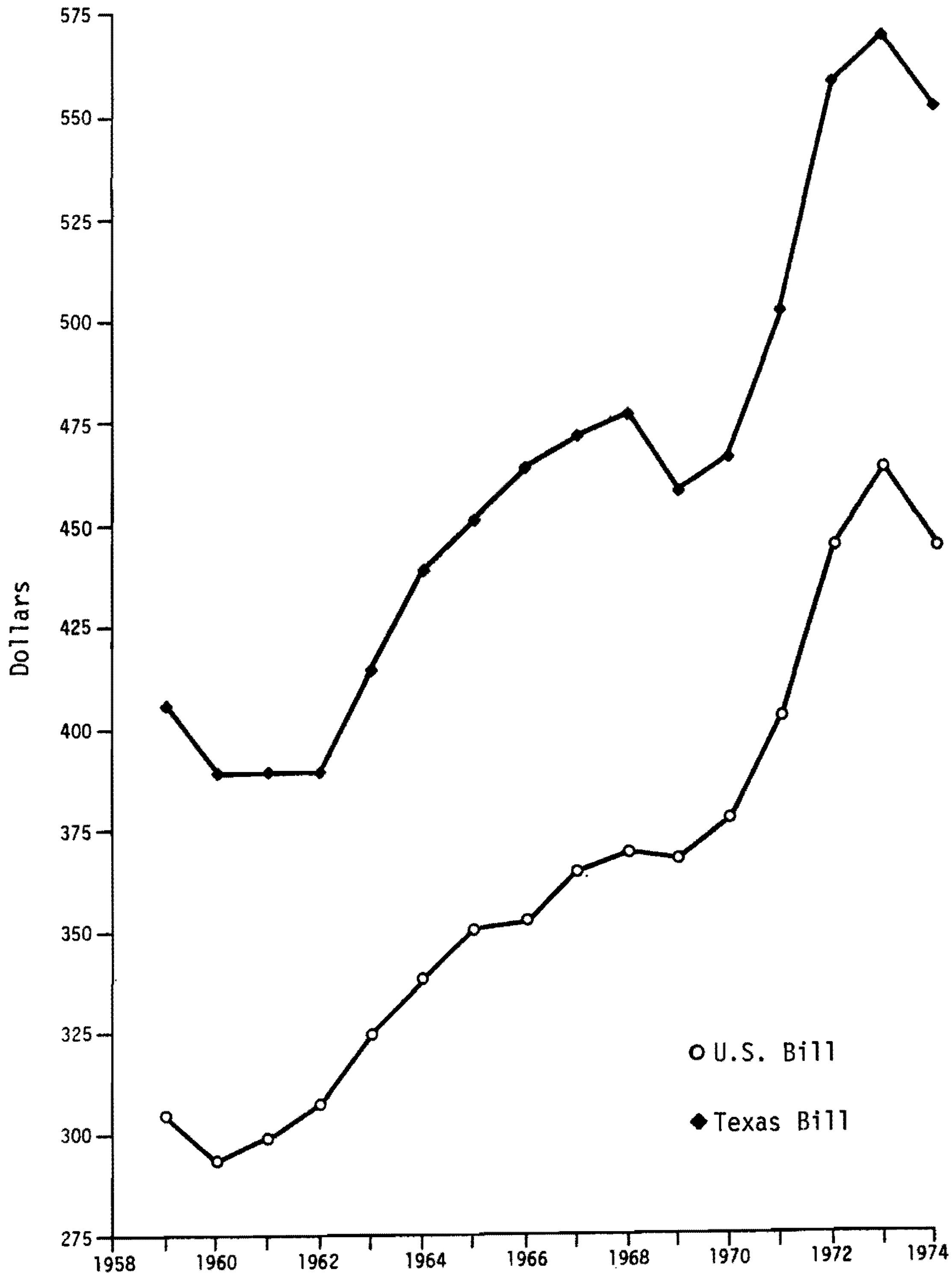


Figure 15. U.S. and Texas Total Freight Bills Per Capita (in constant dollars)

greater magnitude of the Texas freight bill per capita relative to the U.S. per capita bill implies that the role of freight transportation in the functioning of the Texas economy is greater than the general role of freight transportation in the U.S. economy.

The long-run trends of the state freight bill and the U.S. freight bill are very similar as illustrated in Figure 15. From 1959-1974, the Texas freight bill had a net increase of 143.84 dollars while the U.S. freight bill had a net increase of 140.03 dollars. Short-run fluctuations of the U.S. and state bill generally occur at the same time and in the same direction. Declines in the U.S. freight bill are usually accompanied by declines in the Texas freight bill. The three recessionary periods mentioned earlier are clearly visible in Figure 15 as downturns in the state and national freight bills. Texas' freight transportation industry recovery from the 1960 through 1961 recession was slower than the recovery of the U.S. freight transportation sector. Additionally, Texas' freight transportation industry was injured more than the U.S. freight transportation industry at the onset of the 1968-70 recession. The state and the national freight bills both responded about the same to the recessionary year of 1974.

The study emphasis now turns to the per capita bills of the components of the total freight bill. Each modal bill will be examined in turn to determine which freight transportation means contribute to the freight transportation expenditure intensiveness of Texas.

THE HIGHWAY FREIGHT BILL PER CAPITA

A large share of the freight transportation intensity of Texas is explained by highway freight expenditures. Figure 16 shows that Texas' per capita freight bill exceeds the U.S. per capita bill for every year

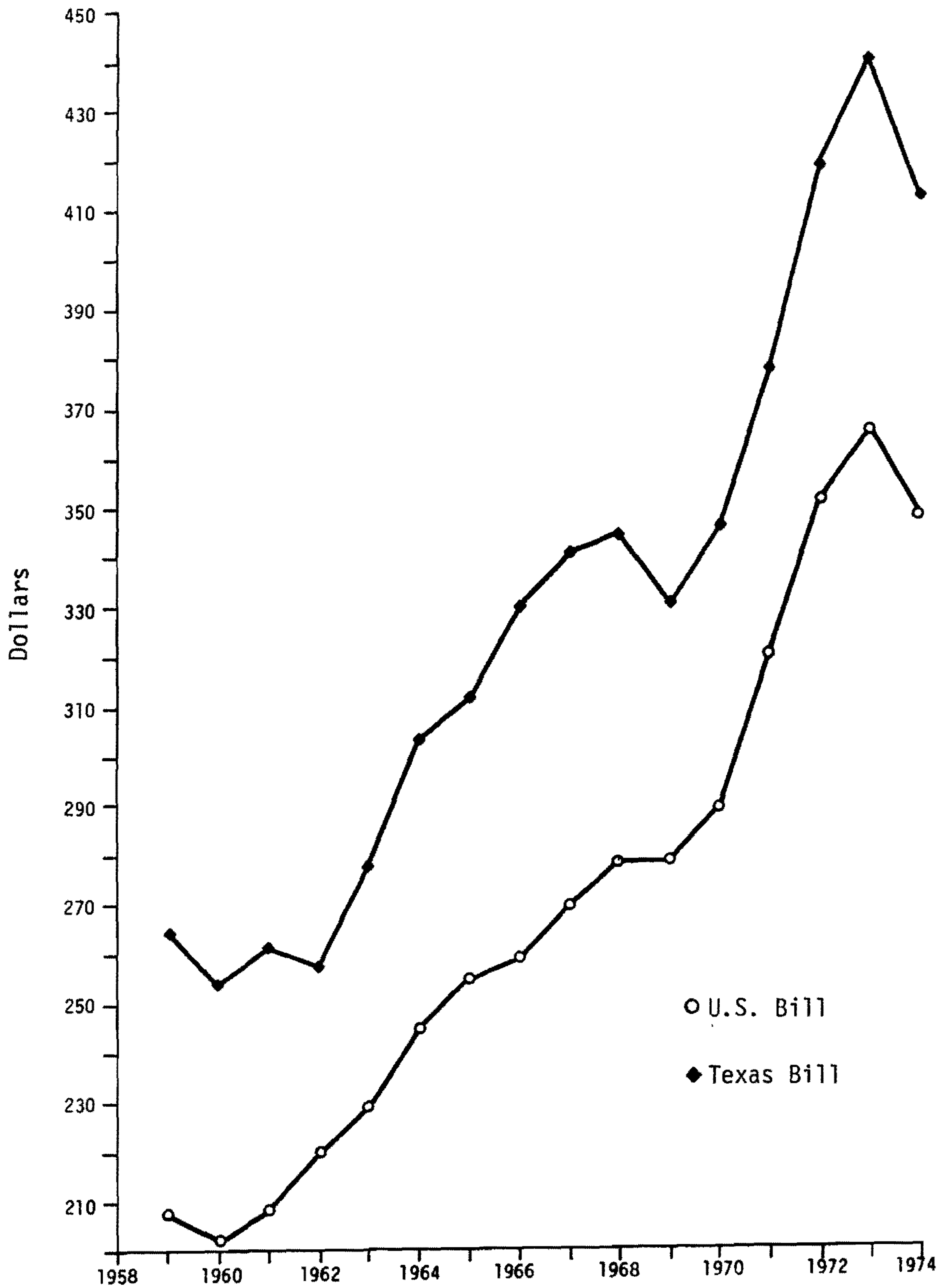


Figure 16. U.S. and Texas Highway Freight Bills Per Capita (in constant dollars)

from 1959 through 1974 by an average of 57.85 dollars per capita. The larger per capita expenditure in Texas relative to the U.S. and an average 70.8 percent highway freight bill share of the total freight bill in Texas suggests that highway freight transport plays the major role in the state's freight bill intensiveness.

The long-run trend of the Texas and the U.S. per capita highway bills are approximately the same. From 1959 through 1974 the Texas highway freight bill per capita increased 55 percent, while the U.S. highway freight bill per capita increased 69 percent. In addition, the state and national highway bill growth trends almost match their respective total freight bill trends. Generally, the same short-run fluctuations occur both in the state and U.S. highway bills per capita.

A further investigation into the components of the Texas highway freight bill produced the information shown in Figure 17. Per capita freight bills in the state for intercity trucking and local trucking are represented for the years 1959 through 1976. The Texas bus freight component of the highway freight bill is exceedingly small in relative magnitude and, hence, excluded from the analysis of Figure 17.

Before 1970, the intercity highway freight bill in Texas was always larger than the Texas local highway freight bill. Due to an extremely rapid growth rate in the local highway bill, the relative position of the local and intercity bills was reversed. The fast growing local trucking bill might be due to the trend of increasing urbanization in Texas. Residential and industrial concentration in urbanized areas has the propensity to increase the amount of local freight transportation services consumed.

Another potential reason for the fast growing local trucking bill per capita is increased ton-mile costs. Since local trucking involves more

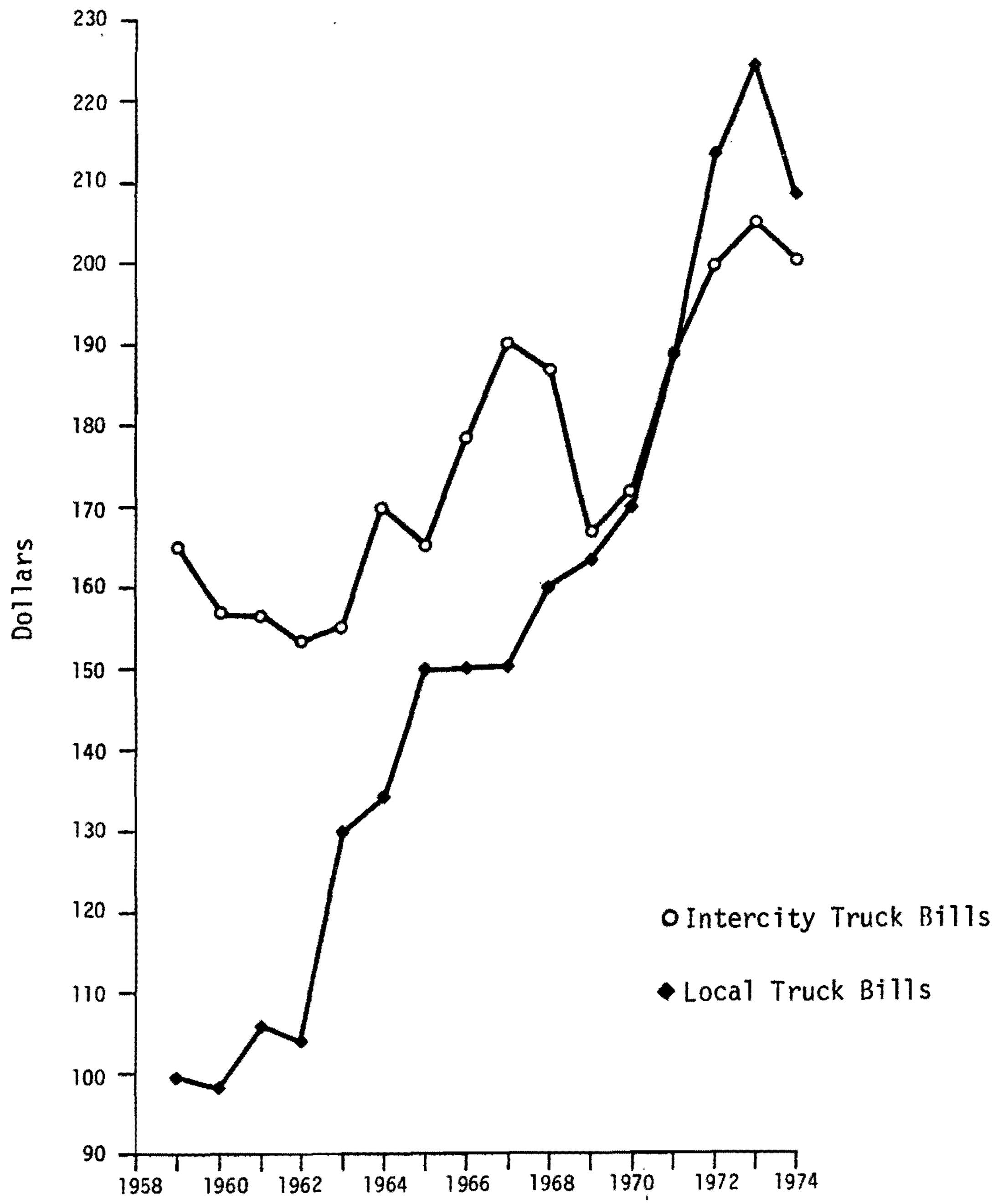


Figure 17. Texas Intercity and Local Truck Bills Per Capita

freight handling and labor per ton-mile than intercity trucking, a rise in driver and freight handler wages will cause the local trucking bill to rise relative to the intercity bill [14]. Additionally, increasing city traffic congestion might cause both wages and other truck operation costs per ton-mile to rise faster for local trucking than for intercity trucking.

In intercity trucking, the relatively flat per capita bill growth trend could have been due to increased efficiencies. For example, long-haul costs per ton-mile might have been significantly reduced as a result of a system of interstate highways. The interstate highways offered intercity trucking more direct routes and faster operating speeds which suppressed ton-mile operating costs. Also, more efficient equipment and greater payloads per truck might have helped to keep the intercity trucking costs low relative to local trucking costs.

During the early recession years of 1960 and 1961, the intercity trucking bill in Texas declined more than the local trucking bill. In the 1968 through 1970 recession, the local trucking bill continued to grow while the intercity bill drastically fell. This phenomenon may have been due to the great importance of domestic economic conditions upon intercity trucking. Depressed conditions in other regions in the nation decreased the use of intercity transport relative to local transport. During the 1974 through 1975 recession, growing export activity from Texas ports might have prevented a drastic decline in the intercity trucking bill relative to the local trucking bill; most of the long-haul trucking through Texas to the port facilities probably continued. Increased operating costs of long-haul trucking relative to local trucking operating costs possibly occurred during the latter recession. Early in 1974, the speed limit for trucks traveling Texas highways was reduced by the legislature. As a result, a loss of some long-haul trucking efficiencies may have increased costs per mile, and in turn, increased the intercity bill per capita versus the local bill per capita.

THE RAILROAD FREIGHT BILL PER CAPITA

Expenditures per capita on rail freight transportation in Texas since 1971 have been greater than the U.S. per capita rail freight bill. Therefore, Texas has only in recent years been rail freight intensive relative to the U.S. as a whole. Over the sixteen years included in this study, the U.S. rail freight bill has trended down while the Texas rail freight bill has grown. Between 1959 and 1974, the Texas bill per capita had a net growth of 5.21 dollars versus a U.S. bill per capita net decrease of 6.38 dollars.

Although the general long-run trends of the state and the U.S. bills differ, the major downward short-run fluctuations in the state's bill generally correspond with major downward fluctuations in the national bills. During the 1960-61 recession, the per capita bills of the U.S. and Texas both declined drastically by about eight dollars each. Another deline which had a similar effect on both the state and U.S. bills occurred in 1967. From the 1967 downturn until 1972, the U.S. rail freight bill and the Texas rail freight bill both increased. This recent rise in the bills may have been due, at least in part, to the greater U.S. exportation of bulk goods (i.e. bulk agricultural commodities). The reader will note that the increase in the rail freight bills continued during the recessionary year of 1974.

If the relative rail freight transportation and intercity trucking costs are assumed constant during 1973 and 1974, the increased rail freight bill then indicates a shift from trucking to rail freight transportation. If the shift indeed occurred, it was probably the result of the lower relative costs of transporting bulk items by rail and a commensurate switch to more

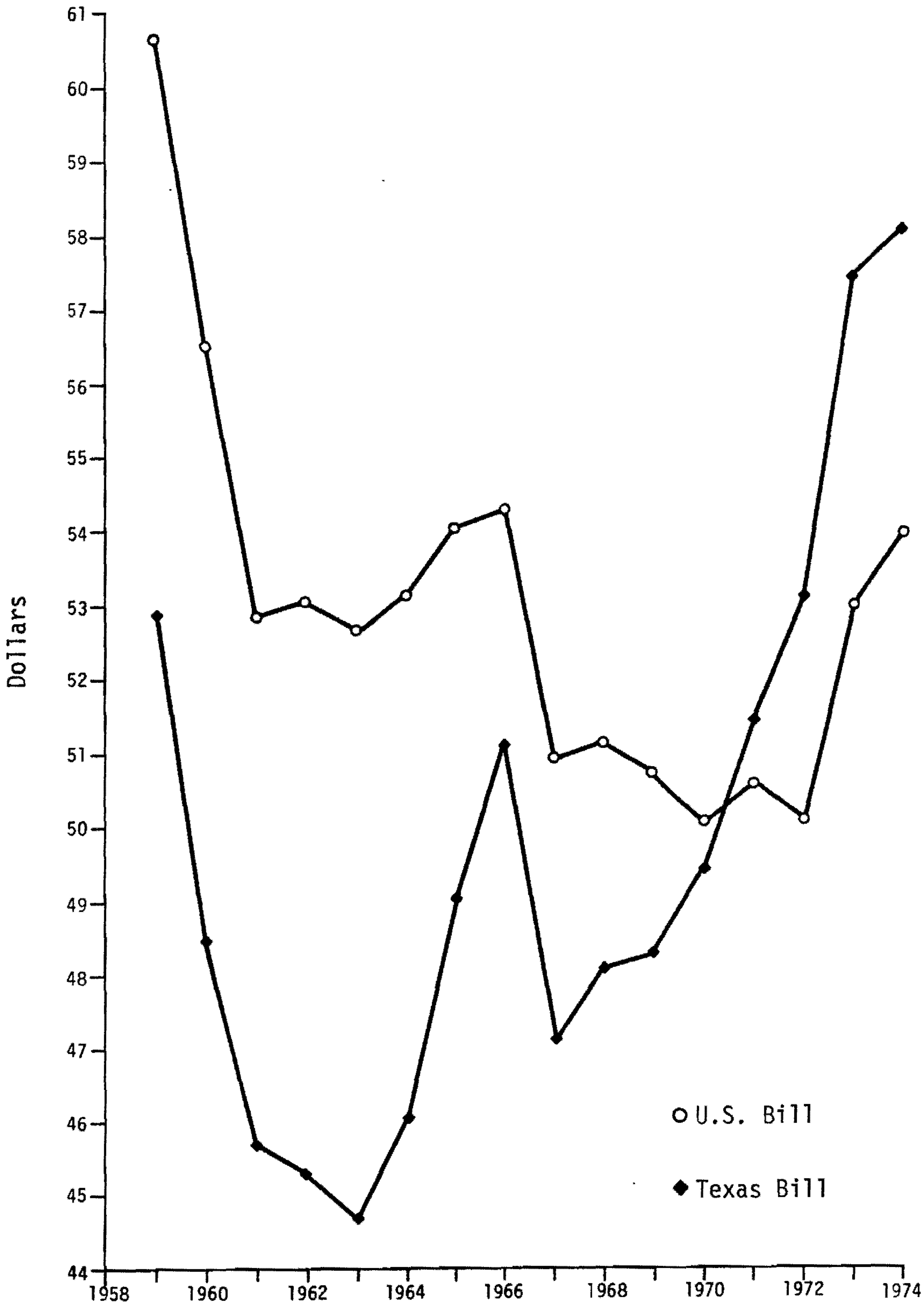


Figure 18. U.S. and Texas Rail Freight Bills Per Capita
(in constant dollars)

rail freight usage for the movement of bulk items. The bulk commodity transportation advantage of rail freight over truck freight is built into the Interstate Commerce Commissions structure of railroad rates by the use of value of service pricing. Value of service pricing assigns high rates to high valued manufactured items and low rates to bulk agricultural or raw material products [11].

The bill increase in 1974 might also have been due to increased usage brought about by a general decrease in the relative cost of rail transportation versus other modes. Such innovations as unit trains, piggy back trailers, containers on flat cars, and 100 ton hopper cars have reduced railraod freight costs per ton-mile [11].

On the other hand, the increased bill may simply be the result of increased cost per ton-mile of rail freight transportation accompanied by little or no increases in rail transportation usage. Further study to determine the cost relationships of the various freight transportation modes is necessary before the occurance of a modal freight transportation shift can be established.

THE TEXAS WATER FREIGHT BILL PER CAPITA

Texas is water freight transportation intensive relative to the U.S. as a whole. Figure 19 illustrates that the per capita water freight bill exceeds the U.S. per capita counterpart. In 1959, the Texas bill exceeded the U.S. bill by approximately 14.11 dollars; by 1974 the Texas bill was 15.66 dollars greater than the U.S. water freight bill. The Texas intracoastal waterway system and the state's excellent port facilities combine to make Texas a leading user of water freight transportation. For example, in 1965 and 1970, Texas' share of the total U.S. waterborne commerce tons was 15.0

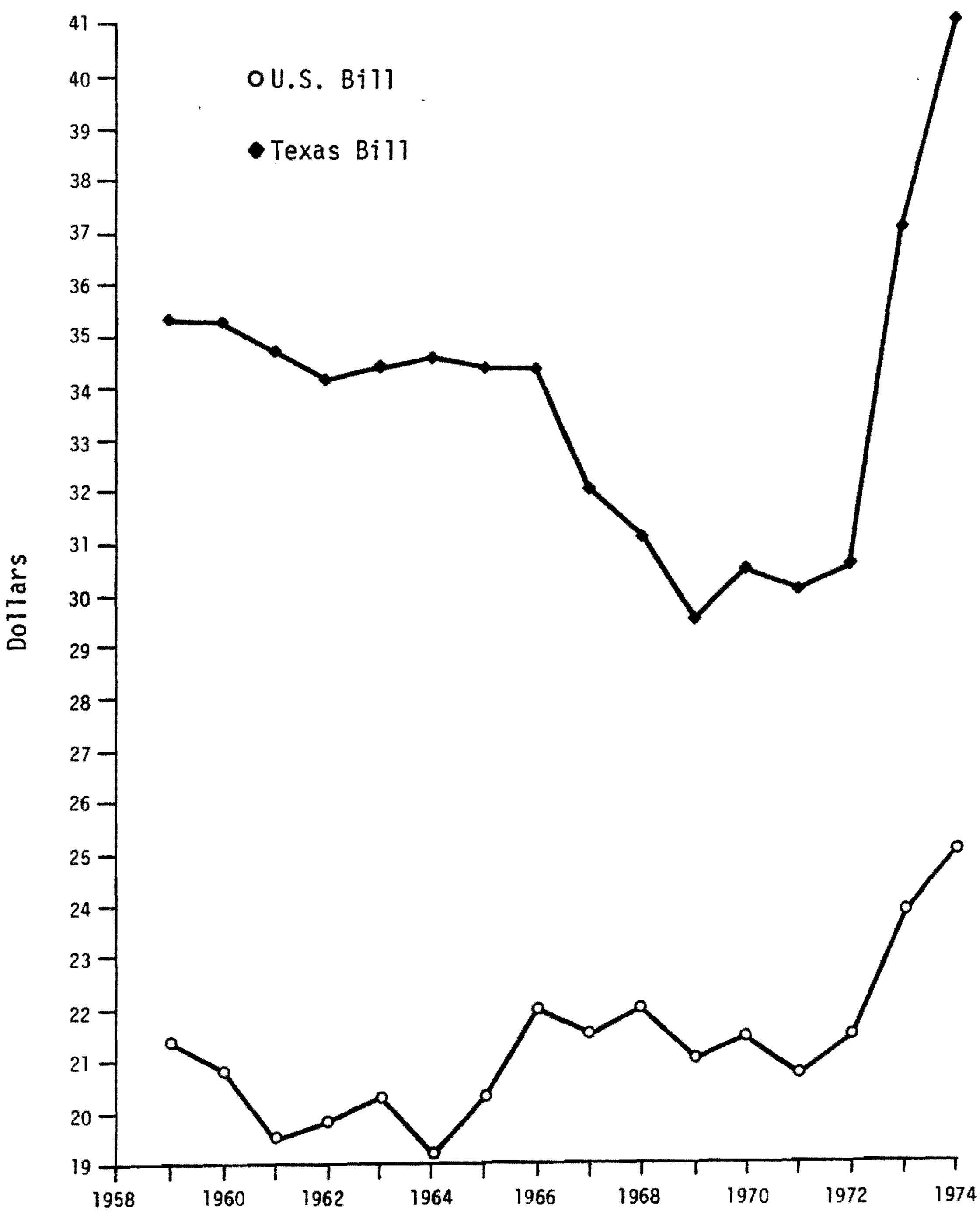


Figure 19. U.S. and Texas Water Freight Bills Per Capita (in constant dollars)

and 12.6 percent respectively; the figures are somewhat higher than the Texas share of GNP.

After the foreign exchange rates were realigned late in 1971, the exportation of commodities from the U.S. increased rapidly [8]. This increase in export activity might have been the cause of a rapid upward trend for both the U.S. and Texas water freight bills from 1971 through 1974. The Texas water freight bill increased 1.15 times from 1959 through 1974, while the U.S. water freight bill increased 1.17 times over the same period. Most of the slight upward trend over time could have been caused by increased water transportation usage and not by rapid increases in water freight transportation costs.

THE TEXAS OIL PIPELINE BILL PER CAPITA

Figure 20 illustrates that Texas is oil pipeline transportation intensive relative to the entire U.S. Over the long-run the per capita Texas pipeline bill is 29.41 dollars above the national per capita average bill. The greater Texas bill per capita is expected since the State is a major domestic producer of crude oil and petroleum products. Crude is moved largely by pipeline from major oil fields in West Texas and East Texas to coastal refineries. Refined products are moved principally by pipeline from the refineries to markets in other petroleum allocation districts. In 1970, an estimated 54.9 percent of all intercity freight ton-miles hauled in Texas was moved via petroleum pipelines [12]. This share compares to 19.1 percent of the total freight ton-miles hauled in the U.S. through pipelines [13].

From 1959 through 1974, the Texas oil pipeline bill per person has declined a net 7.13 dollars (a fall of about 19 percent of the 1959 bill). The decline might be the result of efficiency gains in pipeline operations such

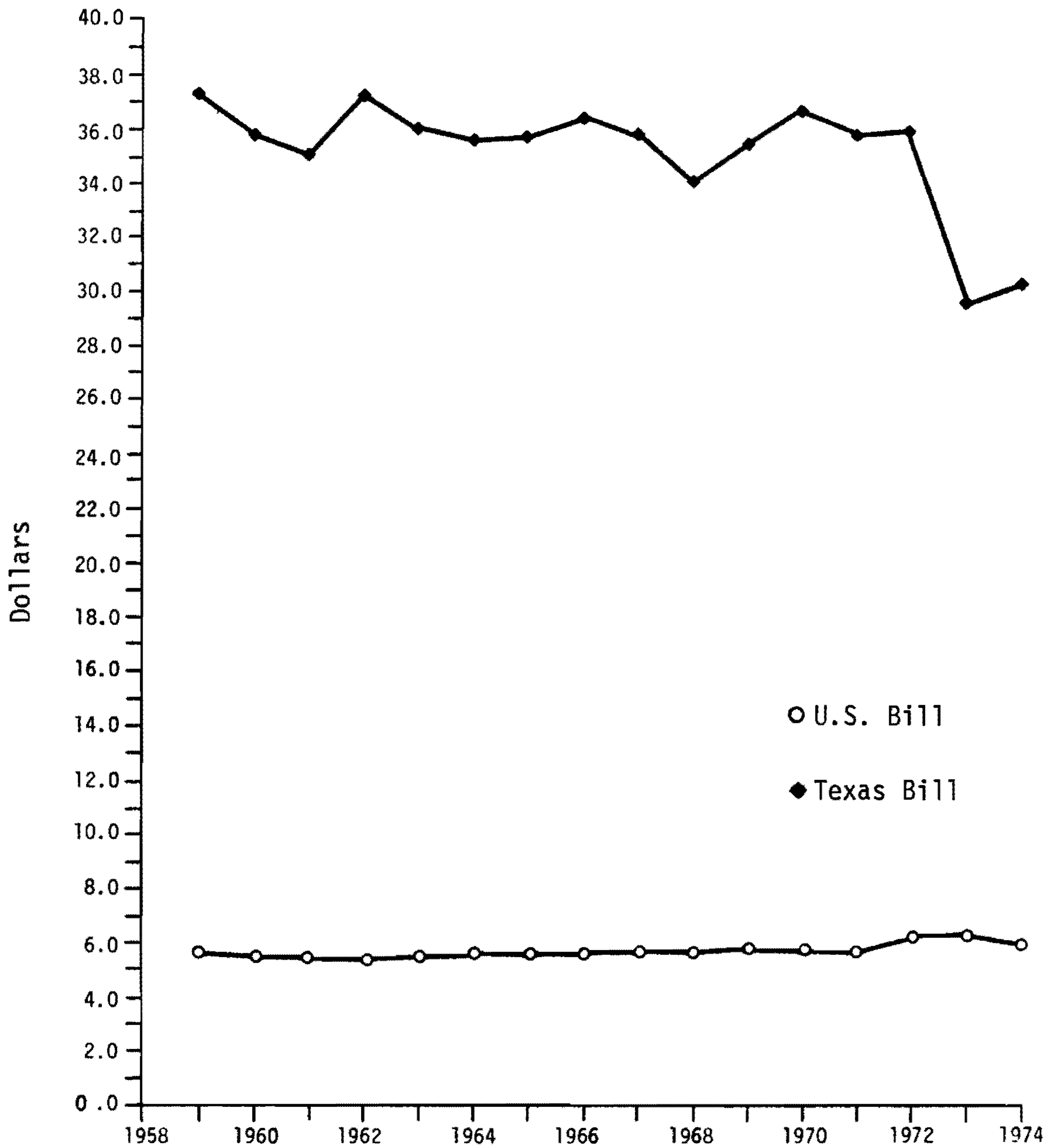


Figure 20. U.S. and Texas Oil Pipeline Bills Per Capita (in constant dollars)

as higher pumping pressures and larger diameter pipes. Although the Texas bill per capita declined, the U.S. bill remained relatively stable at about 5.70 dollars. The effects of the Arab oil embargo might have caused the largest one year decline in the pipeline bill. In 1973, the embargo year, the transportation of refined products from Texas fell possibly in response to decreased supplies of crude inputs. As a result, the 1973 decline in the bill was probably due to a fall in pipeline transportation usage rather than a rapid decline in costs.

THE TEXAS AIR FREIGHT BILL PER CAPITA

Texas is not air freight transportation intensive relative to the U.S. as clearly demonstrated in Figure 21. Over the long-run, the U.S. air freight bill has averaged approximately 1.82 dollars above the Texas air freight bill. Although both bills have similar long-run growth trends, the short-run fluctuation of the U.S. and Texas bill do not always coincide in either direction or magnitude. The per capita 1974 air freight bill in Texas was 4.25 times the 1959 bill, while the U.S. per capita air freight bill grew 2.62 times the 1959 level. The growth in the Texas and the U.S. air freight bills over the years is probably due to increases both in usage and costs.

THE OTHER FREIGHT BILL PER CAPITA

The other freight bill includes the expenditures for the service of freight forwarders and express freight handlers plus other shipper costs such as, the loading and unloading of freight cars. Texas' per capita bill was greater than the U.S. per capita bill for each year from 1959 through 1974. Additionally, the trend is toward fewer expenditures for these services over time. The decreasing trend may be the result of increased efficiency in

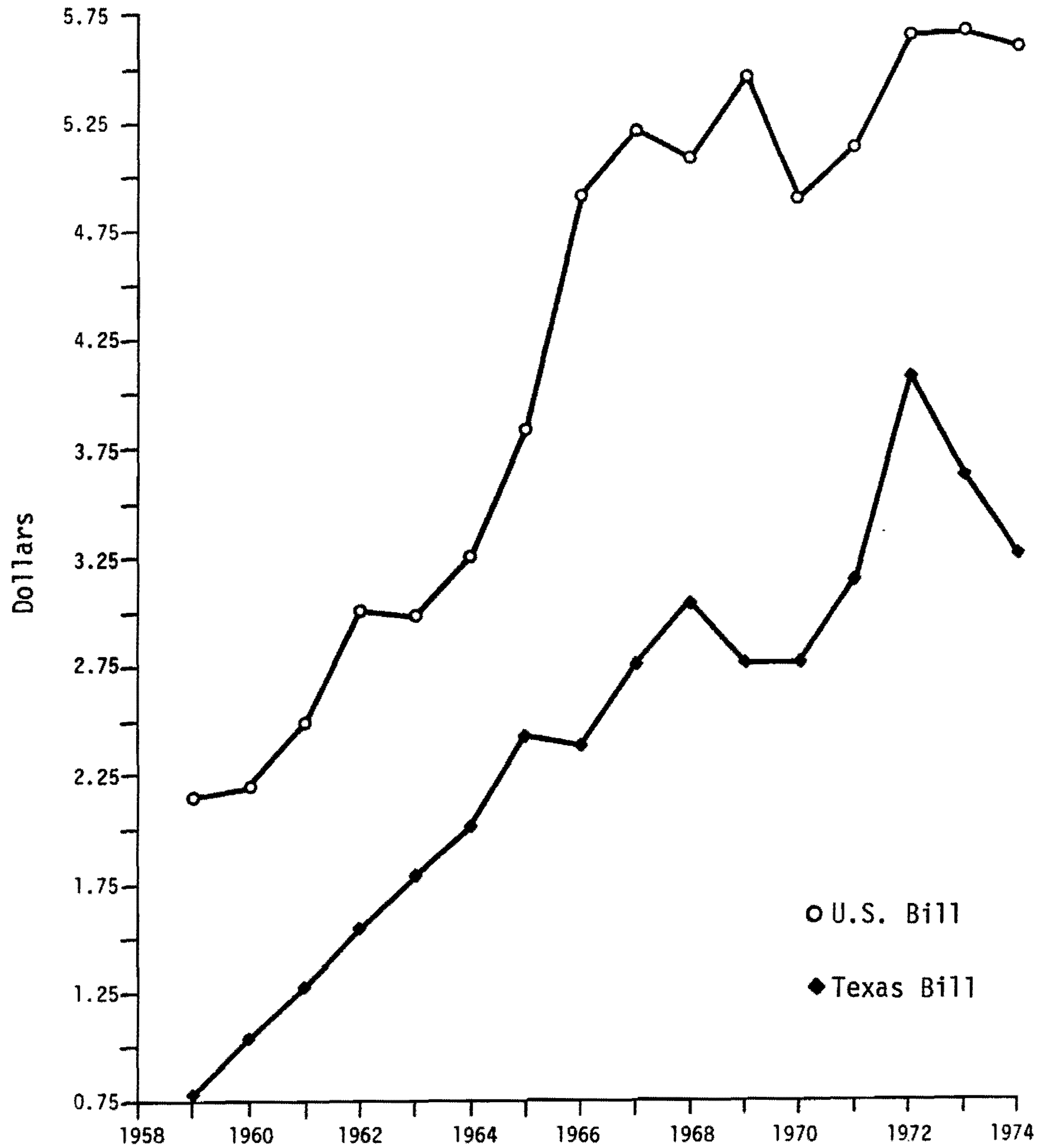


Figure 21. U.S. and Texas Air Freight Bills Per Capita
(in constant dollars)

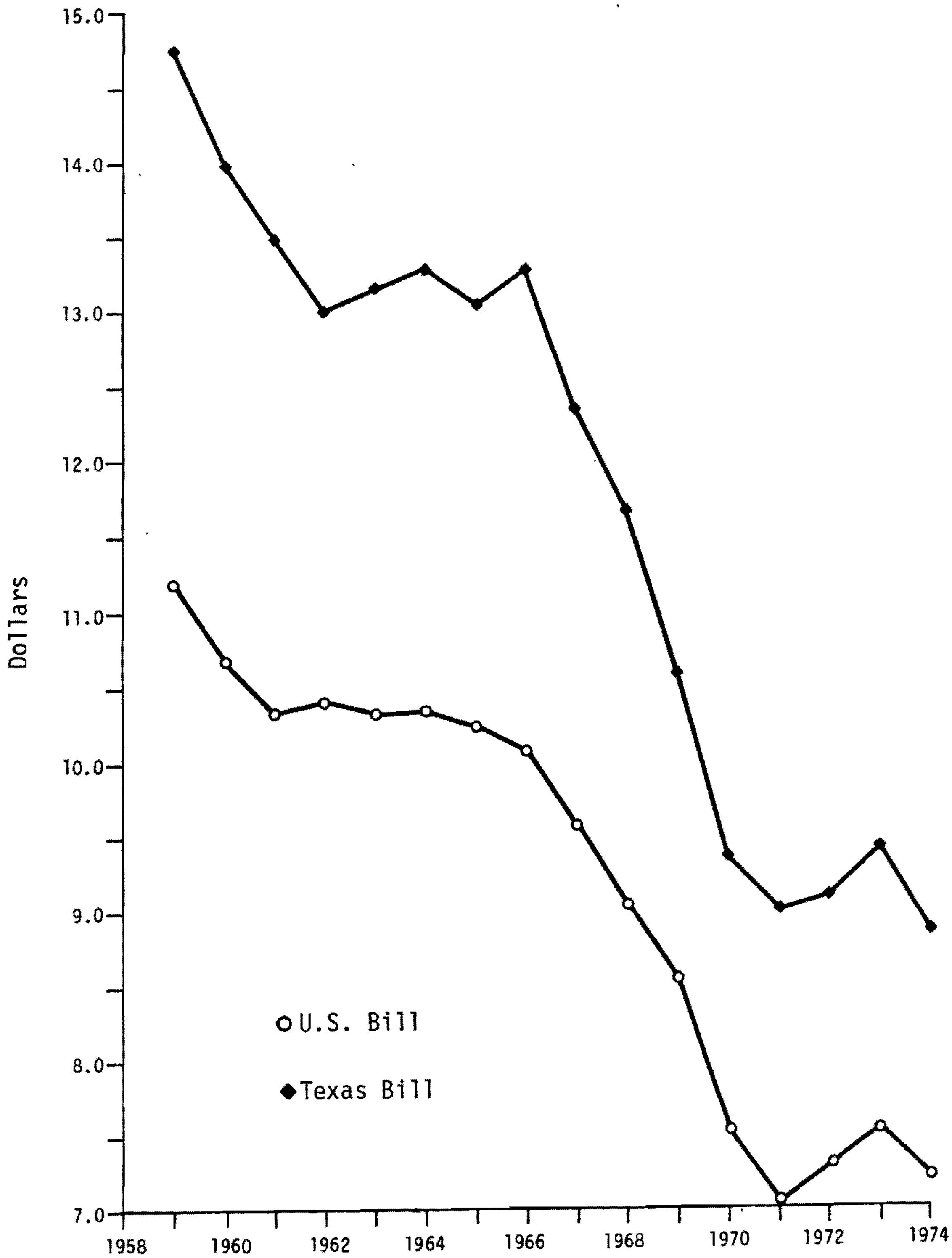


Figure 22. U.S. and Texas Other Freight Bills Per Captita
(in constant dollars)

freight handling or the incorporation of freight handling and freight forwarding into firms which themselves directly transport the freight.

SUMMARY OF THE PER CAPITA ANALYSIS

In summarizing, Texas was auto and air passenger intensive relative to the U.S. Per capita expenditures in all other passenger modes in Texas were less than the expenditures in the U.S. passenger mode counterparts. Additionally, auto, air passenger, general aviation, and school bus transportation expenditures per person have increased in Texas while rail, bus, taxi, and transit expenditures per person in the state have decreased. Every passenger mode trend in the state was similar to the respective U.S. passenger mode trend. The similarity is with respect to direction and rate of growth. Only the air passenger bills and the school bus bills had state trends that were generally different from national trends.

Approximately 90 cents of the 1959 passenger dollar was spent on auto transportation compared to about 88 cents of each passenger dollar spent on automobile transportation in 1974. Bus, taxi, and transit expenditures fell from a three cent portion of the 1959 passenger dollar to a two cent 1974 dollar share. General aviation and air passenger expenditures rose from six cents of the passenger dollar in 1959 to about ten cents of the 1974 passenger dollar. The school bus share of the dollar remained at a one cent level over the sixteen years studied while the rail passenger expenditure share remained relatively insignficant. Texas' per capita passenger expenditures in 1974 were 1.45 times the per capita passenger expenditures of 1959. The Table 6 illustrates the expenditure distribution of each passenger dollar per person in Texas and the U.S. for the years 1959 and 1974. Since the state passenger bill per capita is almost the same size as the national passenger bill per capita (the Texas bill was 1.04 times the national bill in 1974), the relative U.S. and Texas distribution of the dollar reflects the conclusion of the analysis of each per capita bill. This similarity in the distribution of dollar expenditures and the distribution of the total bill does not hold in the analysis of the freight bill.

Table 6

How the Passenger Transportation
Dollar was Spent

	1959		1974	
	Texas	U.S.	Texas	U.S.
Auto	89.6¢	86.8¢	88.2¢	84.6¢
General Aviation	.9	1.6	1.8	2.6
Bus, Taxi and Transit	3.2	4.9	1.7	2.8
School Bus	.5	.8	.6	1.2
Rail Passenger	.5	1.4	.0	.3
Air Passenger	5.3	4.5	7.7	8.5
TOTAL	100.0¢	100.0¢	100.0¢	100.0¢

Texas is freight transportation intensive relative to the U.S. The highway, water, oil pipeline, other freight and recently rail freight transportation modes contribute to Texas' intensiveness relative to the U.S. with regard to freight transportation expenditures. Regulated air service is the only state transportation means bill which was consistently less than the national bill. The Texas freight bill per capita in 1959 and 1974 was respectively 1.32 and 1.23 times the national freight bill per capita. This clearly indicates that much more per person has been spent on freight transportation in Texas than the nation.

In 1959, approximately 65.1 cents of the Texas freight transportation dollar was spent on the movement of freight via truck and bus. By 1974, the highway freight transportation expenditures had increased to about 74.3 cents of the state's freight movement dollar. The railroad's share of the Texas freight transportation dollar fell from 13.0 cents in 1959 to 10.6

cents in 1974. Water transportation and petroleum pipeline transportation expenditures each represented almost a 9.0 cent share of the 1959 dollar while in 1974 their share decreased to 7.4 cents and 5.5 cents respectively. Air freight transportation, which had an almost insignficant portion of the 1959 dollar, captured approximately 1.3 cent of the 1974 Texas freight transportation dollar. Other freight costs such as freight forwarders, and express freight agents' share of the dollar fell from about 3.7 cents in 1959 to 1.6 cents in 1974. Table 7 illustrates the distribution of the freight dollar expenditure in Texas versus the U.S. in 1959 and 1974.

Table 7

How the Freight Transportation Dollar was Spent

	1959		1974	
	Texas	U.S.	Texas	U.S.
Highway	65.1¢	67.1¢	74.3¢	78.1¢
Rail	13.0	19.7	10.6	12.1
Water	8.8	7.0	7.4	5.6
Pipeline	9.2	1.9	5.5	1.3
Air	.2	.7	.6	1.3
Other	3.7	.36	1.6	1.6
TOTAL	100.0¢	100.0¢	100.0¢	100.0¢

Although more was spent per capita on highway freight transportation in Texas than in the U.S., the portion of each dollar spent for highway freight was greater in the U.S. than in Texas (74.3 cents in Texas versus 78.1 cents in the U.S.). Additionally, in 1974 the total per capita expenditures railroad freight transportation were greater in Texas than in the U.S., while more of each freight dollar was spent in the U.S. than in Texas for rail freight transportation. Although much more was spent per capita on water freight movement in Texas than was spent for the same service in the U.S., there is only a 1.8 cent differential in the water freight dollar distribution of the U.S. versus the Texas dollar distribution. Out of each freight transportation dollar spent in Texas, 4.2 cents more than the U.S. expenditure share goes to pipeline transportation; this is by far the largest dollar distribution difference.

Indeed, Texas is freight transportation intensive since more is spent per person for the movement of freight in Texas than is spent for the same reason in the U.S. The distribution of each freight dollar spent in Texas and the freight dollar distribution in the U.S. are different. Areas such as water and pipeline transportation receive a disproportionately greater share of the freight dollar in Texas. Highway and rail transportation receive a disproportionately smaller share of the freight dollar.

The next section of this study deals specifically with an extrapolation of future transportation expenditures from the distributional trends of past transportation expenditure patterns.

TEXAS TRANSPORTATION BILL FORECASTING

A method of quickly and accurately forecasting the transportation bill for Texas would be of enormous benefit to transportation policy makers. The future transportation bill estimates could be used to aid in decision making with regard to setting transportation rates and transportation-related taxes along with planning transportation systems. Although the bill forecasts themselves may not be the sole determining criteria in policy making, the bills may be a primary input in the decision process and used in conjunction with other pertinent data.

Estimators that will enable the approximation of future transportation bills for Texas are presented in this section. The TTI transportation bill estimators or equations will yield the future bills if the following four categories of information are provided:

(1) estimates of Gross Texas Product;

(2) estimates of the constant dollar average Texas gasoline price,

(3) estimates of Texas population,

(4) estimates of the Purchasing Power of the Dollar price index.

The resulting bill from each equation is expressed in per capita terms and, therefore, must be multiplied by Texas population to derive to total bill. Every equation in this section is specified in per capita terms to make the per capita relationships highly visable in the equation.

Data in the form of the per capita transportation bills, the per capita GTP, the constant dollar gasoline prices (which were presented earlier in this study) and the price indexes (specifically the Purchasing Power of the Dollar index) are used to construct estimates of the future transportation bills for Texas. The transportation bill equations derive from least-squares regression of the per capita transportation bill against the explanatory variables of per capita GTP, Texas gasoline prices and the price index. Each equation characterizes the relations of observations on the four variables for the years 1959 through 1974.

Gross Texas Product in per capita terms is included as an explanatory variable because it reflects more than simply the relationship between output and the transportation bill. The effects of personal income are included in the GTP relation with the transportation bill since personal income is a major component of state gross output. In addition, the per capita GTP coefficient in the equations also reflects productivity effects which may be ignored using per capita income data alone. The per capita GTP coefficient, therefore, is useful in estimating the effect of a change in Gross Texas Product (or any variable which might be correlated with GTP, such as personal income or productivity) upon the transportation bill per capita.

Gasoline price was included as an explanatory variable in the equations principally because it represents much more than simply the effect of the price of gasoline upon the transportation bill. Since some modes do not use gasoline, the price of gasoline and its relation to a few specific modal bills, such as rail and water freight, might seem weak. The prices, however, are a good indiator of the costs of other petroleum-based fuels used in transportation. In a sense, gasoline prices are shadow prices of the other fuels and thus changes in retail gasoline prices are accompanied by similar directional changes in other fuel prices. The use of the gasoline price variable in the estimation equation abstracts from the price differentials and substitution between petroleum-based fuels. Additionally, the gasoline price coefficients in the equations might characterize more than fuel costs. All variable costs may be included in the coefficients to the degree that the variable costs are correlated with the price of gasoline. For example, the relationship between the price of tires and the highway freight bill component of the total freight bill might be included in the gasoline price coefficient since increases in the price of tires might have occurred along with gasoline price increases.

The price index was included in the list of explanatory variables principally as a result of the high degree of statistical significance or explanatory power that the price index has in the regression of past transportation bills. The significance of the price index might be due to a residual effect from inflation upon the constant dollar transportation bill.

Care must be taken when interpreting the coefficients of the equations. Although the variables are stated in per capita terms, the equations do not represent the average Texan's demand function for transportation. The equations are not specifications of how the individual Texan reacts in the purchase of passenger and freight transportation to state gross product, gasoline price, and price index changes. The equations specify the aggregate input or gasoline cost, gross product and transportation bill relations which are controlled for changes in population.

THE TEXAS TRANSPORTATION BILL FORECAST EQUATIONS

Three equations used for forecasting the Texas transportation bill per capita are presented in this section. Each equation is structured specifically to forecast per capita expenditures for transportation given estimates of per capita gross product (GTP), constant dollar gasoline prices, and the estimates of the price index (PPD). The Texas transportation bill forecast for any given year is obtained by multiplying the per capita forecasts, generated via the equations, by the population estimate for the respective year.

A specification of the relations between the explanatory variables and the per capita passenger bill is shown in Equation 1. Similarly, Equation 2 expresses the per capita freight bill relations with the explanatory variables. The total transportation bill per capita may be determined from the sum of passenger and freight bill equation forecasts or the total bill can be determined directly by the use of Equation 3, the total transportation bill forecasting equation.

(1) Total Passenger Bill Per Capita = 380.000 + .0703(GTP) + 26.991(Gas Price) -203.008(PPD)

$R^2 = .961$

(2) Total Freight Bill Per Capita = 432.222 + .0557(GTP) + 28.860(Gas Price) - 185.611(PPD)

$R^2 = .914$

(3) Total Transportation Bill Per Capita = 812.223 + .1259(GTP) + 55.851(Gas Price) - 388.619(PPD)

$R^2 = .950$

The positive sign of the per capita GTP coefficient in each equation indicates that as the gross product per person increases, the respective bill tends to increase. This implies that there is a direct and positive relationship between output per person and transportation expenditures per person in Texas. Additionally, the positive gasoline price coefficient indicates that there is a direct and positive relationship between gasoline prices and per capita transportation bills. The impact of the negative price index coefficient is more difficult to sort out. The price index effect has a negative influence upon the transportation bill; as inflation increases the price index becomes smaller, thereby, reducing the negative influence of the price index coefficient.

Each equation is followed by a multiple regression R^2 value. The R^2 gives an indication of how much the variation of the transportation bill is explained by variation in GTP per capita, gasoline price and the price index. For example, approximately 96.1 percent of the variation in the passenger bill is determined or explained by the variation in the three explanatory variables.

Forecasts of the Texas Transportation Bill

The three equations were used along with estimates of the explanatory variables (see the Appendix C for the underlying assumptions and sources of the explanatory variable estimates) to derive forecasts of the Texas Transportation bill shown in Table 8. The forecasted data are presented in current dollar terms for the major passenger, freight and total categories.

Table 8

Forecasts of the Texas Transportation Bill*
(in millions of current dollars)

	1977	1980	1985	1990
Total Passenger Bill	$13,076.0	$17,685.0	$27,712.3	$43,496.9
Total Freight Bill	$13,062.1	$17,470.6	$26,996.6	$41,843.0
Total Transportation Bill	$26,138.1	$35,155.6	$54,708.9	$85,339.9

*Preliminary Forecasts

A significant growth in the current dollar passenger, freight and total transportation bills over the forecast years is obvious. A comparison between the passenger and freight bills indicates that in 1977 the passenger bill is 1.001 times the freight bill; however, by 1990 the passenger bill is forecasted to be 1.040 times the freight bill. This trend in the increasing relative size of the Texas passenger bill supports the hypothesis stated earlier with respect to the evolution of Texas transportation to a more passenger intensive transportation expenditure mix. The forecasts also illustrate that transportation in Texas will sustain a 27 to 25 percent relative share of Gross Texas Product. Passenger and Freight bills in constant dollars are forecasted to grow 62.5 percent and 56.4 percent respectively over the twenty-four years from 1977 through 1990. This represents an average annual growth in the constant dollar passenger bill of 2.6 percent and an average annual growth in the constant dollar freight bill of 2.4 percent.

APPENDIX A

EXPLANATION OF METHOD USED FOR CALCULATING TEXAS PASSENGER AND FREIGHT BILLS FOR 1959-74

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 1974. 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 [14]. 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 [15]. 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 tolls, auto registrations, and license fees were gathered from the U.S. Department of Transportation state level data [16]. The auto insurance expenditures in private transportation were obtained from the state insurance commission [17]. 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 the use of TAA methodology [14]. The interest figure was determined by using 15 percent of the annual new and used car sales. In consequence detailed pictures of the 1959-74 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 methdology.

In order to arrive at estimates of bus, taxi and city transit passenger bills in Texas for 1959 through 1974, the Texas input-output study figures were used [18]. 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. [19]. 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 [20].

Air passenger transportation expenditures in the state for 1959-1974 were calculated by totaling the revenues attributable to Texas operations for each airline serving the state [21]. Total airline revenues were apportioned by the individual carrier's annual percentage of Texas enplaned passengers to total enplaned passengers [22].

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 [23] times the average hours per aircraft [24] which, in turn, were multiplied by the average fuel consumption per hour of each aircraft type [25]. 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 [26]. After 1970, almost the entire rail passenger transportation bill was derived from AMTRAK data presented by TTI [9]. Estimates of rail passenger miles were 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 bills 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 and 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 [16]. 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 [19]. 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 1959-74 was determined by multiplying total urban truck-miles [16] by estimated average cost per mile [27]. 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 1-1 1/2 ton vehicles (the factor being the relationship to total vehicles [28]) 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 [13]. This driver cost was updated in direct proportion to the average union wage increases for the respective years [3].

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 [26].

Yearly estimates of the state's water transportation bill were basically drawn from the 1967 input-output study for Texas [18]. 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 [3] and port tonnage for 1959-72 [29] and for 1973-75 [30] 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 [22] allocated on the basis of the percentage of state enplaned freight tons to total enplaned tons for each air carrier [21].

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 1959-74. For 1967, the input-output study dollar output figure was used [18]. 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 to pipeline companies in the U.S. for the respective years [31]. Since total U.S. pipline wages were known along with 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 [19]. 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. Added details in attempts to be more inclusive may lead to the employment of less desirable techniques in order to compensate for the lack of data availability.

APPENDIX B

SOURCES FOR GROSS TEXAS PRODUCT

Sources for Gross Texas Product

Estimates of Gross Texas Product for the years 1967-1974 are taken from Adair (6). Gross Texas Product for 1975 and 1976 is estimated as 5.2% of Gross National Product for 1975 and 1976 as reported in Kellner (32).

APPENDIX C

METHOD USED FOR ESTIMATING THE EXPLANATORY VARIABLES

The per capita transportation bill forecasts are determined by the use of the three forecasting equations and estimates of the three explanatory variables. Since the equations are per capita estimators, the forecasts derived from the estimators are in turn multiplied by Texas population forecasts to arrive at the total transportation bill. The state population estimates used in this study for the forecasted years are University of Texas projections.

The first explanatory variable, per capita gross Texas product, used in the equations is assumed to decline in the annual growth of 3.8 percent in 1977 to 2.3 percent in 1980. This declining growth assumption corresponds to a scenario of Texas' economic recovery from the 1974-75 recession. From 1980 through 1990, the per capita GTP is assumed to grow at a constant rate of 2.3 percent annually [6]. The second explanatory variable, the average Texas gasoline price in constant dollars, is assumed to grow at a fairly constant rate until 1980. After 1980, the price is assumed to level off at .3734 cents per gallon. This scenario of at first increasing and then constant gasoline prices reflects President Carter's proposals for the pricing of crude oil. The Purchasing Power of the Dollar index projections used in the forecast were derived by taking the inverse of the Chase-Econometrics, Inc. forecasts of the Consumer Price Index.

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