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16. Abstract

This report documents most of this project's first objective, namely, to update and expand the TRANSBORDER data base. This report discusses all relevant data collected and organized in this project, with the exception of international bridge demand and U.S.-Mexico overland commerce data, which warranted a separate report (Report 2932-2). This report includes Texas-Mexico multimodal traffic data (rail, airborne, and waterborne), socioeconomic indicators, truck weight analyses, and energy consumption within the transportation sector. For each type of data, we document and discuss data collection procedures, the different data sources, and practical applications of those data.

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TEXAS-MEXICO MULTIMODAL TRANSPORTATION AND SOCIOECONOMIC INDICATORS

by
Angela Jannini Weissmann

Research Report Number 2932-1

Research Project 7-2932
Texas-Mexico Border: Transportation Planning Guidelines and Automated Data Base

conducted for the

Texas Department of Transportation

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

February 1996

IMPLEMENTATION STATEMENT

A 1992 report to Congress, pursuant to Intermodal Surface Transportation Efficiency Act (ISTEA) sections 1089 and 6015, acknowledges that El Paso and Laredo, Texas, are among the nation's busiest ports of entry. Accordingly, it recommends the development of federal-aid program options to improve the transportation infrastructure related to international trade. In order to take advantage of this recommendation, border states must not only monitor their transborder traffic demand, they must also keep updated data on issues that affect transportation planning along their international borders. Data collection and reduction are, however, expensive and time-consuming tasks, especially when undertaken within a binational environment, requiring as it does a bilingual staff, international networking, and experience with another country's procedures and agencies. In order to streamline such data collection and storage, the Center for Transportation Research (CTR) of The University of Texas at Austin developed in 1993 the TRANSBORDER data base for use by the Texas Department of Transportation (TxDOT). The primary objective of the present study is to update and expand the scope of the TRANSBORDER data base.

The availability of updated data contributes to TxDOT's transportation planning and budgeting in two ways: First, a single, updated TRANSBORDER data base can lead to the economies of scale brought about through such a centralized data base. Second, the data base allows TxDOT to approach border transportation planning dynamically; that is, TxDOT can use the data immediately (1) to assess infrastructure needs, (2) to quantify the use of Texas' infrastructure by other states' commerce with Mexico (see Report 2932-2), (3) to assess the impacts of the peso devaluation on transborder traffic (see Report 2932-2), (4) to evaluate modal splits along the border, and (5) to gain an understanding of energy and air quality issues related to transportation in Texas and in Mexico. The project findings can also assist TxDOT in fulfilling Texas Legislative Article 6673j-1 of the Texas Civil Statutes, which requires TxDOT to report on the ability of Texas' transportation system to handle the traffic demand generated by international trade. Finally, the data contained in this report provides evidence that Texas is the major national gateway for NAFTA commerce, and that it sustains, as a consequence, a disproportionate share of such negative impacts as pollution, excessive energy consumption, and infrastructure damage.

ACKNOWLEDGMENTS

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Prepared in cooperation with the Texas Department of Transportation.

DISCLAIMERS

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SUMMARY

Texas' border transportation needs are a function of trade and economic growth, both of which have been exceeding the best available forecasts. Indeed, most of the growth in exports forecast by the State Comptroller's Office to occur over the five-year period from 1990 to 1995 had already occurred by 1994. As a result, Texas may need $100 million or more to update its border transportation infrastructure.

Clearly, it is important that these expenditures be optimized. And two approaches to such optimization include (1) economies of scale provision and (2) accurate assessments of what percentage of these expenditures are needed to serve other states' international traffic. Both approaches depend on prompt availability of up-to-date trade and transportation data in order to implement dynamic transportation planning and to demonstrate the need to fund the nation's import/export corridors that utilize Texas' infrastructure. For these reasons, the Texas Department of Transportation (TxDOT) initiated the present study, whose objectives are: (1) to update and expand the TRANSBORDER data base; (2) to analyze the early NAFTA and peso devaluation impacts on border transportation demand; and (3) to estimate that portion of U.S.-Mexico trade originating in other states but relying primarily on Texas' infrastructure.

This report documents most of the project's first objective, namely, to update and expand the TRANSBORDER data base. It discusses all relevant data collected and organized in this project, with the exception of international bridge demand and U.S.-Mexico overland commerce data, which warranted a separate report (Report 2932-2). This report also includes Texas-Mexico multimodal traffic data (rail, airborne, and waterborne), socioeconomic indicators, truck weight analyses, and energy consumption within the transportation sector. For each type of data, we document and discuss data collection procedures, the different data sources, and practical applications of those data.

As testimony to the border area's importance, an ambitious binational study is about to get underway, one financed by the U.S. and Mexican Governments and the World Bank, and administered by the Arizona Department of Transportation. That study's main objective is to develop guidelines for coordinated binational planning, part of which includes developing a comprehensive data base. While seemingly comprehensive, that study will not pursue objectives that are Texas-specific. We therefore propose that TxDOT begin the process of quantifying the infrastructure needs resulting from Texas' important role as a major trade corridor. Accordingly, we recommend research to investigate such relevant issues as:

(1) additional highway capacity needed in Texas as a result of other states' international commerce passing through the state;

(2) pavement rehabilitation needs resulting from other states' international commerce;

(3) traffic safety hazards related to other states' international commerce passing through the state; and

(4) mobile source emissions in Texas non-attainment areas (e.g., El Paso) generated by vehicles serving other states' international commerce.

Studies such as those listed above can help Texas obtain its share of funds for transportation infrastructure and for attainment of Clean Air Act requirements. Results of these studies can also help relieve Texas border communities — El Paso, Laredo, and many others — of the congestion, pollution, and environmental degradation resulting from NAFTA-driven trade traffic.

CHAPTER 1. INTRODUCTION

THE TEXAS-MEXICO BORDER AREA

While traffic patterns and practices within the Texas-Mexico border region have always been somewhat idiosyncratic (and have thus required customized actions for their efficient planning and programming), recent events at the national level have ensured that the character and volume of transportation in this important area will continue to undergo dramatic flux. The recent passage of the North American Free Trade Agreement (NAFTA), for example, has generated new waves of transborder traffic, while the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has encouraged changes in transportation modes. As a result, the most recent border transportation studies describe a region that is undergoing constant change. These studies call for a dynamic transportation planning approach, and recommend that traffic demand, economic indicators, and other data relevant to transportation planning be continually monitored (Refs 1.1–1.8).*

For its part, the Texas Department of Transportation (TxDOT) has adopted a proactive response to the border's shifting transportation patterns. Various TxDOT research studies, including Projects 1312, 1319, 1976, and 2932, have investigated Texas-Mexico border infrastructure needs, capacity utilization and potential demand, and trade issues (Refs 1.1–1.8). They have identified problems and have proposed solutions to many of the issues now reported in the Binational Border Transportation Planning and Programming Study jointly sponsored by the U.S. and Mexican governments.

Among these recent studies, TxDOT Project 1976 has been particularly relevant, insofar as it has enhanced transportation research and planning through its development of the TRANSBORDER data base (Ref 1.4). As that study's report makes clear, data collection and reduction are expensive and time-consuming tasks, especially when conducted within a binational environment (requiring as it does bilingual staff, international networking, and experience with other country's procedures and agencies). The availability of a continuously updated TRANSBORDER data base can prove instrumental to TxDOT, since such a data base can promote economies of scale by building upon the scope of previous work and by serving most of TxDOT's research and planning purposes. Availability of these updated guidelines are also instrumental for TxDOT's transportation planning and budgeting: Again, they promote economies of scale through a centralized data base and, at the same time, assist TxDOT in its efforts to pioneer the implementation of a dynamic approach for border transportation planning, an approach whose need has already been recognized at both state and federal levels (Refs 1.2–1.8).

BACKGROUND

The dynamics of the border region make difficult the analysis and forecast of its economic trends. And while several reports on the border have been recently published, much remains to be

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* References appear at the end of each chapter.

done (Refs 1.1–1.9). Transportation needs are a function of trade and economic growth, both of which have been exceeding the best available forecasts. For example, most of the growth in exports forecast by the State Comptroller's Office for the five-year period 1990-1995 had already occurred by 1994 (Ref 1.9). And because Texas may need as much as $100 million to update its infrastructure, it is clearly important that these expenditures be optimized through economies of scale and through accurate assessments of what percentage of these expenditures are needed to serve other state's international traffic. Prompt availability of up-to-date trade and transportation data is thus instrumental in implementing a dynamic transportation planning approach and, moreover, in demonstrating the need to fund the nation's import/export corridors that utilize Texas' infrastructure. The TRANSBORDER data base, developed in Study 1976 to meet these needs, can be used for more detailed research projects, provided it is kept up-to-date.

Inventory Data

The TRANSBORDER data base contains three inventory files that summarize information pertinent to all existing and proposed bridge, dam, and ferry binational entry systems along the Texas-Mexico border. The binational entry systems[1] are numbered according to their distance from the Gulf, as estimated by the International Boundary Water Commission (IBWC).

The MAIN INVENTORY file (INVM.SDS) contains information common to existing and proposed binational entry systems, including names, transportation modes carried, and number of lanes. The EXISTING INVENTORY data set (INVEX.SDS) contains information pertaining only to existing entry systems, including the structural features and characteristics of the inspection facilities. The PROPOSED INVENTORY data set (INVPR.SDS) contains information pertaining exclusively to proposed entry systems, including the status of presidential permits. Table 1.1 summarizes the overall organization of the inventory data.

Table 1.1 Summary of the inventory data

Inventory File	Contents
Main	Inventory information for existing, under-construction and proposed binational entry systems
Existing	Inventory information for existing binational entry systems only
Proposed	Inventory information for proposed binational entry systems only

These inventory files were developed under Study 1976 and updated under Study 2932. Additional information about their electronic formats can be found in Research Report 1976-2 (Ref 1.4). The purpose of the inventory files is to permit easy access to basic information about the binational entry systems, as well as to serve as a data base relational link by binational entry

[1] *Binational entry system* is a term created by TxDOT's International Relations Office to designate the system comprising the boundary between two countries, the border stations and inspection facilities on both sides, and whatever structure might be necessary to cross the border. In the case of the Texas-Mexico border, delineated by the Rio Grande, this structure is usually a toll bridge.

system. Inventory data collected by CTR on a routine basis are available for Project 2932. Inventory data collection, however, is not a task of Project 2932. TxDOT's International Relations Office maintains an updated inventory, which is periodically published in the report, "Texas-Mexico International Border Crossings" (Ref 1.10).

Data Organization by Sector

The sector analysis concept was developed under Project 1976 to facilitate the transportation planning process. It is an aggregated research approach, one in which individual sites are grouped into specific sectors according to potential traffic demand for a new binational entry system in the sector. Such an approach allows planners to address the Texas-Mexico border area from a binational transportation planning perspective. This concept was designed to work in conjunction with traditional trip assignment methods used in traffic demand estimates, and is adequate for regional transportation planning. The border sectors are depicted in Figure 1.1.

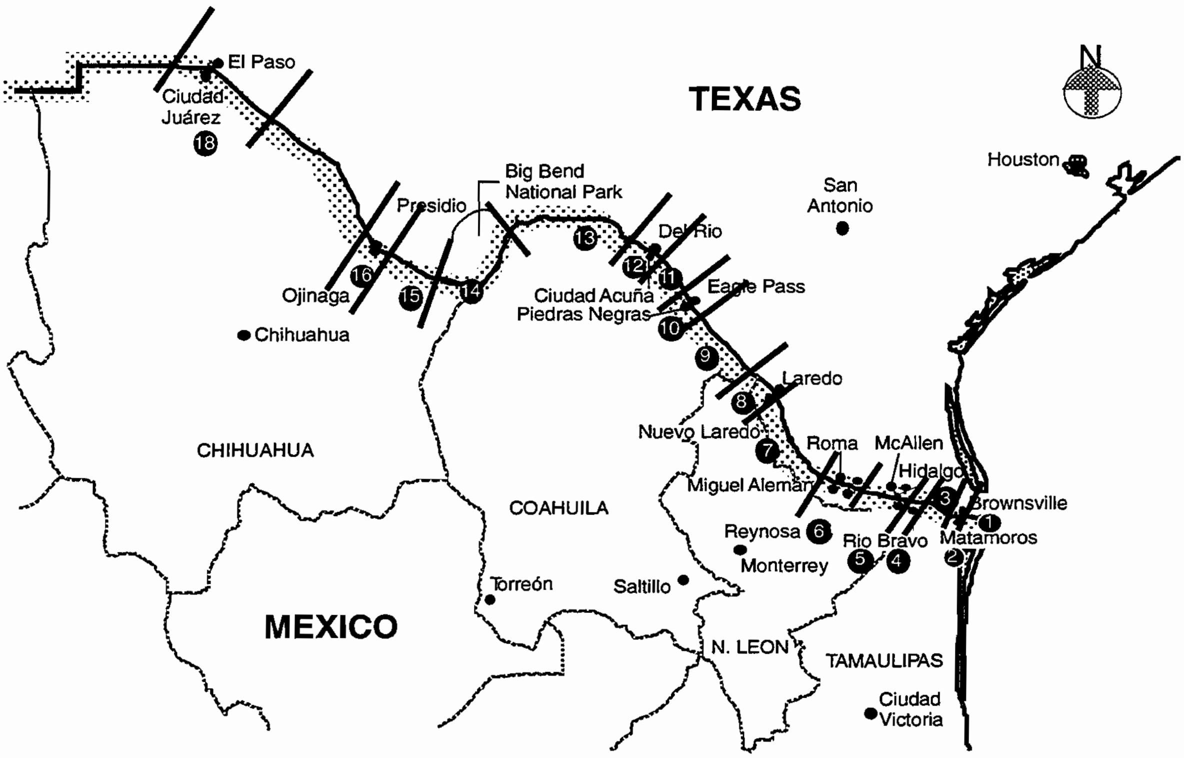

Figure 1.1 Texas-Mexico border sectors

The criteria used to define sectors include the expected traffic diversion and the sphere of influence of socioeconomic characteristics. These areas of economic activity may encompass both sides of the border or one side only. As such, the boundaries depicted in Figure 1.1 should be updated as the areas of economic activity expand.

STUDY OBJECTIVES AND DELIVERABLES

While focusing primarily on data collection, reduction, and storage, the scope of Study 2932 also includes basic data analysis and the development of guidelines for regional transportation planning. Availability of a data base and up-to-date guidelines on border transportation can prove useful in future border transportation projects and for multi-agency organizations (such as those to be developed by the Binational Border Transportation Planning and Programming Study).

Transportation planning data include such socioeconomic indicators as population and employment, as well as traffic volumes, highway condition, and commodity flow data. Data collection, reduction, and storage are the most time-consuming phases of the majority of projects, with the usual hurdles considerably augmented in the case of Texas-Mexico border data. Bilingual staff and familiarity with another country's official agencies and data collection procedures are required in developing a successful international networking and in obtaining the necessary data.

The TRANSBORDER data base developed in Study 1976 contains U.S. and Mexican data relating to the following categories:

(1) Inventory of binational entry systems,
(2) Socioeconomic data,
(3) Traffic history at each binational entry system,
(4) Traffic history at main network links,
(5) Maquiladora indicators,
(6) Infrastructure inventory, and
(7) Origin/destination.

Study 1976 ended in April 1994, and its most recent data were from 1992—before NAFTA's passage. Because a centralized border-related data base requires constant updating to be useful, Study 2932 was initiated to fulfill the objectives of updating and expanding the data base. Specifically, this study's objectives are: (1) to update and expand an existing TRANSBORDER data base; (2) to analyze the early NAFTA and peso devaluation impacts of the border transportation demand; and (3) to estimate what amount of U.S.-Mexico trade uses Texas infrastructure but relates to other states' commerce with Mexico. In pursuing these objectives, Study 2932 has generated the following reports:

(1) Research Report 2932-1, *Texas Mexico Multimodal Transportation and Socioeconomic Indicators,* which documents all data collected by this study, with the exception of transborder traffic at Texas' international bridges, and origins, destinations, and commodity types of U.S.-Mexico commerce.

(2) Research Report 2932-2, *Analysis of U.S. Mexico Traffic through Texas,* documents transborder traffic at Texas' international bridges, and U.S.-Mexico commerce origins, destinations, and commodity types. It also contains an analysis of early NAFTA and peso devaluation's impacts on transborder traffic, as well as a discussion of the use of Texas infrastructure by other states.

(3) Research Report 2932-3F, *Texas' Role as a U.S.-Mexico Trade Gateway,* summarizes one important result of Project 7-2932: the quantification of the amount of U.S.-Mexico trade that uses Texas highway and rail infrastructure, but which has origins and destinations outside Texas. Despite some data limitations, the analyses indicate that Texas is the major gateway for U.S.-Mexico trade.

REPORT OBJECTIVES AND SCOPE

This report documents all data collected and organized in this project, with the exception of transborder traffic and U.S.-Mexico commodity flows, which are discussed in Report 2932-2. It includes descriptions of data collection procedures, comparisons between different data sources, and discussions of practical data applications. During the development of this project, two priorities emerged:

(1) obtain and reduce Mexican data and U.S. data from sources that are time consuming to access, and

(2) concentrate on major issues that will affect transportation planning during the next 10 years.

Two major issues are affecting Texas transportation planning in general, and the Texas-Mexico border in particular, which have potential to become major concerns in the next century: the impacts of transportation in energy consumption and air quality, and infrastructure maintenance to meet a growing demand. Related to the latter is the harmonization of truck weight limits under NAFTA (both Canadian and Mexican regulations permit heavier trucks). Accordingly, this project collected the most recent energy consumption data available in Texas and in Mexico. It also collected as much information as possible regarding Mexican truck weights, including a nationwide truck weight survey in Mexico. Although the project's objectives call for limited data analysis, energy consumption data and truck weight data, combined with transborder traffic and commodity flows by land (see Report 2932-2), clearly indicate a potential problem. Therefore, this project collected the most comprehensive data base on Mexican multimodal transportation and socioeconomic indicators, and obtained analogous data in Texas to supplement data routinely available from TxDOT and USDOT sources.

REPORT ORGANIZATION

This report is organized into six chapters. Chapter 1, "Introduction," identifies relevant background information about the study and the TRANSBORDER data base. Chapter 2, "Energy Consumption by Texas and Mexico Transportation Sector," documents the most recent estimates and forecasts of energy consumed by the transportation sector, both in Texas and in Mexico. Chapter 3, "Mexican Truck Weights," discusses an important issue, one based on a recent nation-wide Mexican survey of truck weights. Related to the energy consumption and truck weight issues is "Multimodal Transportation in Texas and Mexico," discussed in Chapter 4. This chapter contains updated information about rail, air, and waterborne transport, which this study collected, organized, and analyzed for TxDOT's multimodal transportation planning. Chapter 5 documents recent socioeconomic indicators, including sales data in Texas cities and updated socioeconomic indicators in Mexican border states. Chapter 6, "Summary, Conclusions, and Recommendations," finalizes the report with a summary of the data base contents, a discussion about transportation planning data needs, and recommendations for future studies and for future data collection for the border area.

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CHAPTER 2. ENERGY CONSUMPTION BY TEXAS AND MEXICO TRANSPORTATION

BACKGROUND AND OBJECTIVES

The U.S. is the world's largest consumer of petroleum. And while consumption of petroleum appears to have a positive relationship with U.S. economic health, the fact that much of this energy is imported makes the nation vulnerable to shifts in the world market, and to actions of some politically and socially unstable middle-eastern and African regions. This dependence has been underscored by such events as the oil embargo of 1973-74, the 1978-79 Iranian revolution, and the 1991 Persian Gulf War.

Within the U.S., Texas is the greatest consumer of energy. If regarded as a separate political entity, Texas has the fifth highest energy consumption in the entire world, behind the rest of the U.S., China, Japan, Germany, and the former Soviet Union (Refs 2.4, 2.7, 2.8). Looking at energy sources, Texas is the largest consumer of natural gas, petroleum, and electricity, and the fourth largest consumer of coal (Ref 2.5). The principal energy source for transportation is petroleum, which has supplied over 90 percent of the state's energy needs since 1960. Natural gas is the next major source of energy for transportation, though its share of total consumption declined from 6.8 percent in 1960 to 3.9 percent in 1992. Similarly, liquid petroleum gas (LPG) represented less than 0.1 percent among all energy sources for 1992, down from 1.0 percent in 1960 (Ref 2.5).

Texas' transportation-related energy consumption has led to declining air quality, greater dependence on imported petroleum, more rapid depletion of non-renewable resources, and higher costs to the motoring public. These issues have heightened apprehensions regarding energy consumption within transportation planning, though current efforts to move toward more efficient transportation in Texas are driven primarily by air quality concerns.

While the situation is considerably less problematic in Mexico, transportation energy consumption is an indirect concern in such areas as Mexico City, where reliance on the automobile, combined with a geographical location unfavorable to pollutant dispersion, has created one of the worst air qualities in the world. In addition, and more importantly, Mexican energy consumption trends indicate an increasing reliance on less efficient modes, such as automobiles, and a decrease in use of rail, one of the most energy efficient modes available. Thus, the motivation behind many current studies on energy consumption in transportation is an attempt to alleviate these problems by promoting greater efficiency in the transportation sector (Refs 2.3, 2.4).

TRANSPORTATION ENERGY CONSUMPTION IN TEXAS

A recent Center for Transportation Research (CTR) study sponsored by the Texas Sustainable Energy Development Council (SEDC) outlined various strategies for reducing energy consumption and associated pollutant emissions in the Texas transportation sector (Refs 2.3, 2.4).

Because that project's report provides the most recent and most comprehensive data on energy consumption in the Texas Transportation sector, it was used in this project.

Data Description

As part of the SEDC study, the researchers estimated current and future energy consumption within the Texas transportation sector, based on the amount of travel in Texas by transport mode, geographic region, vehicle type, fuel type, and trip purpose (Refs 2.3, 2.4). Figure 2.1 shows the energy use categories utilized in the energy study. Large urban areas are defined as urban concentrations of 200,000 or more inhabitants; small urban areas are those communities having populations of less than 200,000 (column III in Figure 2.1).

Tables 2.1 through 2.5 present the current and projected energy use in the Texas transportation sector. These data reflect end-use only — that is, only the energy consumed to propel the vehicles. According to the data, the Texas transportation sector consumed 2,156 PJ in 1994 (PJ=10^{15}J="Peta-Joules"). The study projects a steady increase in energy use through the year 2020, with the increase resulting primarily from population growth and associated increases in personal driving and economic activity. By 2020, energy use in the transportation sector will have increased by 44.2 percent to 3,110PJ. Projections are based on the hypothesis that current practices and policies will be sustained (Ref 2.4).

Our data source also includes estimates of upstream energy consumption in the Texas transportation sector (Refs 2.3, 2.4). Upstream energy consists of energy consumed during fuel extraction (at coal mines, oil wells, and so on), fuel production (e.g., oil refineries), and fuel transport (gas and oil pipelines, coal trains, etc.). Table 2.6 presents Texas upstream energy consumption in the transportation sector by fuel type. A comprehensive analysis of energy consumption in the transportation sector — or any other sector — must include an estimate of both end-use and upstream energy, since the latter can be higher than end-use within a particular economic sector.

Data Discussion

Texas energy consumption in transportation will remain dominated by petroleum-based fuels, though alternative fuels are forecast to increase steadily during this period (based on the hypothesis that current alternative fuels legislation will be sustained over the entire analysis period). By location, intercity transportation energy use begins to increase at a rate higher than that for the state's urban areas. The intercity share of energy use increases from 53.5 percent in 1994 to 55.6 percent in 2020, with most of this growth driven by the passenger sector. Intercity passenger transportation's share of energy consumption increases from just above 25.3 percent in 1994 to over 28.5 percent in 2020. Actual energy consumption increases for all modes, and the highway surface transportation system remains the major mode of operation for passenger and freight transportation in terms of energy use. As a percentage of total consumption, however, the highway sector's share of energy use remains steady (around 67.5 percent of the total) during the period from 1994 through 2020, as improvements in vehicle fuel economy and greater utilization of alternative fuels are offset by the increase in personal and freight transport in the highway sector (Ref 2.4).

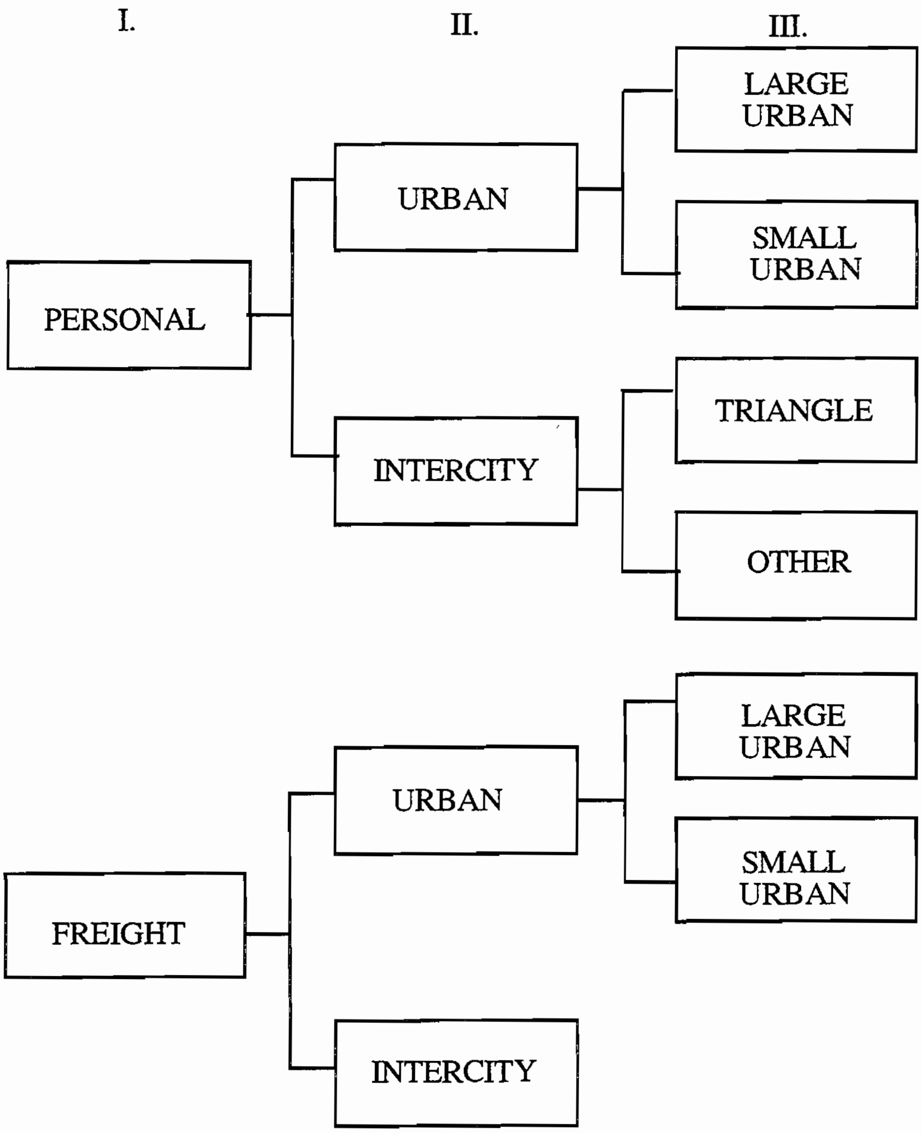

Figure 2.1 Major categories of Texas traffic demand

Table 2.1 Statewide energy use in Texas ($10^{15}J$)

AREA	MODE	1994	2000	2005	2010	2020
PERSONAL-LARGE URBAN	TRANSIT-WORK	2.1	3.2	3.2	3.2	4.2
	TRANSIT-OTHER	5.3	6.3	6.3	7.4	8.4
	AUTOMOBILE-WORK	134.0	144.5	156.1	168.8	188.8
	AUTOMOBILE-OTHER	243.7	260.6	279.6	299.6	338.7
	LIGHT TRUCK-WORK	36.9	36.9	38.0	40.1	44.3
	LIGHT TRUCK-OTHER	63.3	64.4	66.5	69.6	77.0
	SUB-TOTAL	485.3	515.9	548.6	587.6	660.4
PERSONAL-SMALL URBAN	TRANSIT-WORK	1.1	1.1	1.1	1.1	2.1
	TRANSIT-OTHER	2.1	2.1	3.2	3.2	3.2
	AUTOMOBILE-WORK	53.8	58.0	62.2	67.5	76.0
	AUTOMOBILE-OTHER	97.1	104.4	111.8	120.3	135.0
	LIGHT TRUCK-WORK	14.8	14.8	15.8	15.8	17.9
	LIGHT TRUCK-OTHER	25.3	25.3	26.4	27.4	30.6
	SUB-TOTAL	194.1	206.8	220.5	235.3	264.8
PERSONAL-INTERCITY-TRIANGLE	AUTOMOBILE	9.5	10.6	11.6	12.7	13.7
	LIGHT TRUCK	2.1	3.2	3.2	3.2	3.2
	RAIL	0.0	0.0	0.0	0.0	0.0
	AIR	6.3	8.4	9.5	10.6	13.7
	SUB-TOTAL	19.0	21.1	23.2	25.3	30.6
PERSONAL-INTERCITY-OTHER	AUTOMOBILE	162.5	179.4	195.2	211.0	241.6
	LIGHT TRUCK	51.7	54.9	58.0	62.2	70.7
	RAIL	0.0	0.0	0.0	0.0	0.0
	TRANSIT	4.2	5.3	5.3	6.3	7.4
	AIR	309.1	367.1	413.6	457.9	534.9
	SUB-TOTAL	527.5	606.6	672.0	737.4	854.6
FREIGHT-LARGE URBAN	LIGHT TRUCK	2.1	3.2	3.2	3.2	3.2
	MEDIUM TRUCK	54.9	61.2	66.5	71.7	83.3
	HEAVY TRUCK	144.5	162.5	178.3	193.1	225.8
	NATURAL GAS PIPELINE	22.2	20.0	19.0	16.9	13.7
	SUB-TOTAL	224.7	246.9	265.9	284.9	324.9
FREIGHT-SMALL URBAN	LIGHT TRUCK	1.1	1.1	1.1	1.1	1.1
	MEDIUM TRUCK	22.2	24.3	27.4	29.5	33.8
	HEAVY TRUCK	53.8	60.1	65.4	71.7	83.3
	NATURAL GAS PIPELINE	22.2	20.0	19.0	16.9	13.7
	SUB-TOTAL	99.2	106.6	111.8	118.2	131.9
FREIGHT-INTERCITY	LIGHT TRUCK	1.1	1.1	1.1	1.1	2.1
	MEDIUM TRUCK	40.1	45.4	49.6	53.8	61.2
	HEAVY TRUCK	226.8	254.3	278.5	302.8	352.4
	RAIL	33.8	35.9	39.0	41.1	45.4
	WATER	247.9	268.0	283.8	300.7	333.4
	AIR	5.3	6.3	7.4	7.4	9.5
	PETROLEUM PIPELINE	8.4	8.4	9.5	9.5	11.6
	NATURAL GAS PIPELINE	44.3	40.1	36.9	33.8	26.4
	SUB-TOTAL	607.7	660.4	704.7	750.1	842.9
	TOTAL	2156.4	2363.2	2547.8	2739.8	3110.1

Source: Ref 2.4

Table 2.2 Texas transportation energy use by fuel type ($10^{15}J$)

Fuel	**1994**	**2000**	**2005**	**2010**	**2020**
ELECTRICITY	8.4	10.6	14.8	20.0	30.6
NATURAL GAS	91.8	95.0	100.2	106.6	116.1
GASOLINE	979.0	1029.7	1075.0	1123.6	1184.8
BIOFUELS	0	0	0	4.2	15.8
AVIATION GAS	7.4	8.4	9.5	10.6	12.7
HYDROGEN	0	0	0	0	1.1
JET FUEL	314.4	373.5	420.9	465.3	545.4
DIESEL	508.5	573.9	630.9	688.9	820.8
RESIDUAL FUEL OIL	242.7	262.7	278.5	294.3	327.1
LPG	3.2	6.3	10.6	15.8	31.7
ETHANOL	0	2.1	4.2	5.3	8.4
METHANOL	0	1.1	5.3	5.3	14.8
TOTAL	2156.4	2363.2	2547.8	2739.8	3110.1

Source: Ref 2.4

Table 2.3 Texas transportation energy use by transport mode ($10^{15}J$)

Mode	**1994**	**2000**	**2005**	**2010**	**2020**
TRANSIT (P)	15.8	17.9	19.0	21.1	24.3
NON-MOTORIZED (P)	0	0	0	0	0
AUTO & LIGHT TRUCK (P)	893.6	955.8	1022.3	1097.2	1237.5
LIGHT TRUCK (F)	5.3	5.3	5.3	5.3	6.3
MEDIUM TRUCK (F)	117.1	130.8	142.4	155.1	178.3
HEAVY TRUCK (F)	424.1	476.9	521.2	567.6	661.5
RAIL (P & F)	33.8	35.9	39.0	41.1	45.4
AIR (P & F)	321.8	381.9	430.4	475.8	558.1
PIPELINE (F)	97.1	89.7	83.3	77.0	64.4
WATER (F)	247.9	268.0	283.8	300.7	333.4
TOTAL	2156.4	2363.2	2547.8	2739.8	3110.1

P= personal; F=freight
Source: Ref 2.4

Table 2.4 Texas transportation energy use by location ($10^{15}J$)

Location	1994	2000	2005	2010	2020
Large Urban*	710.0	761.7	814.5	873.5	985.4
Small Urban**	293.3	312.3	332.3	354.5	396.7
Inter-City	1154.2	1288.2	1401.0	1512.9	1728.1
Total	2156.4	2363.2	2547.8	2739.8	3110.1

*Population 200,000 or greater
** Population less than 200,000.
Source: Ref 2.4

Table 2.5 Texas transportation energy use by activity ($10^{15}J$)

Activity	1994	2000	2005	2010	2020
Freight - Urban	322.8	352.4	377.7	404.1	456.8
Freight - Intercity	607.7	660.4	704.7	750.1	842.9
Passenger - Urban	679.4	721.6	769.1	824.0	925.2
Passenger Intercity	546.5	627.7	695.2	762.8	885.1
Total	2156.4	2363.2	2547.8	2739.8	3110.1

Source: Ref 2.4

Table 2.6 Texas upstream energy consumption in transportation ($10^{15}J$)

Fuel	1994	2000	2005	2010	2020
Natural gas	150.5	185.5	231.0	278.7	385.4
Gasoline	0.1	0.1	0.2	0.3	0.4
Diesel	1.1	1.3	1.5	1.9	2.7
Residual fuel oil	291.6	314.9	334.3	353.7	393.1
LPG	3.1	3.3	3.6	3.8	4.2
Crude oil	2119.8	2327.2	2503.9	2684.1	3009.9
Wood	0.0	0.0	0.0	4.4	17.5
Hydrogen	0.0	0.0	0.0	0.0	1.4
Petroleum Coke	0.0	0.0	0.0	0.0	0.1
Corn	0.3	1.9	4.3	6.4	9.5
Total	2566.3	2834.2	3078.8	3333.5	3824.3

Source: Ref 2.4

The Texas energy data presented in this document are believed to be the most accurate Texas energy consumption estimates currently available for the transportation sector. Unlike the U.S. Department of Energy (DOE) Energy Information Administration's (EIA) energy data, our estimates are not based on Texas fuel sales; rather, they reflect actual end-use of transportation fuels (Ref 2.4). Texas produces a significant amount of fossil fuels, and a considerable portion of Texas fuel sales are actually used elsewhere; therefore, energy consumption estimates based on fuel sales can overestimate Texas' energy consumption in transportation.

Texas data include 1994 energy use estimates and projections of future use until 2020. The future projections were based on the three assumptions below, intended to simulate the future energy consumption under current transportation policies and preferences. These assumptions imply a small but steady increase in the share of alternative fuels, and in the fuel economy of autos and other vehicles, including those propelled by alternative fuels. These assumptions are:

(1) current transportation policies affecting Texas, such as the alternative fuels program and the Clean Air Act provisions for non-attainment areas, will remain unchanged until 2020;

(2) fuel efficiency of all vehicles, especially autos, will increase during the analysis period; and

(3) changes in modal splits and vehicle occupancy are the result of current policies only, which will remain as those prevailing in 1994 throughout the analysis period.

Readers interested in guidelines for decreasing energy consumption and pollutant emissions within Texas may want to consult two 1995 reports prepared by Euritt, Weissmann, Bernow, et al. (Refs 2.3 and 2.4). The first report, "An Assessment of Transportation Control Measures, Transportation Technologies, and Pricing/Regulatory Policies," (Ref 2.3) discusses the potential impacts of transportation control measures, technology improvements, and transportation pricing policies in energy consumption and air quality. The second report, "Strategies for Reducing Energy Consumption in the Texas Transportation Sector," (Ref 2.4) presents estimates of upstream and end-use energy consumption, as well as emissions. These estimates were made for three hypothetical energy-efficient and environmentally friendly transportation scenarios; also presented is one scenario representing the consequences of revoking current Texas alternative fuels legislation.

TRANSPORTATION ENERGY CONSUMPTION IN MEXICO

The data on transportation energy consumption in Mexico consist of a history of nationwide energy consumption, disaggregated by mode of transportation and/or fuel type. One source also presents passenger versus freight disaggregation (Ref 2.2). The combined data from all sources cover the period from 1975 to 1992 and include a forecast of fuel consumption by passenger cars up to the year 2007 (Ref 2.6). The data were obtained from three sources:

(1) a report on transportation energy use in Mexico prepared by the Lawrence Berkeley Laboratory of the University of California (Ref 2.2);

(2) a publication from the "Instituto Mexicano del Transporte" (Ref 2.1); and

(3) a working paper by Arturo Vieyra Fernández (of the Mexican Secretariat of Mining and Industry) that discusses automobile energy use in Mexico (Ref 2.6).

Like the Texas energy data, the Mexican energy consumption forecasts were based on the hypothesis that current transportation policies and mode splits will remain the same throughout the analysis period. In addition, the Mexican transportation energy data represent end-use energy consumption in transportation.

Data Description

Mexican energy data are depicted in Tables 2.7 through 2.11. Whenever available or applicable, the information is disaggregated by trip category (urban and interurban). The energy consumption estimates do not include light trucks; air travel energy consumption includes fuel loaded for international flights and thus partly consumed outside Mexico.

Tables 2.7 and 2.8 were obtained from the Lawrence Berkeley Laboratory (Ref 2.2). Table 2.7 summarizes passenger travel data from 1975 through 1990. For each year, the first column shows billions of passenger-kilometers of travel (10^9PKT), as well as the respective energy consumption. Table 2.8 summarizes the total energy consumption by mode and fuel type.

Table 2.7 Energy consumption and vehicle-km of travel for passengers in Mexico

		1975		1983		1988		1990	
Mode	**Trip Type**	PKT (10^9)	Energy (PJ)	PKT (10^9)	Energy (PJ)	PKT (10^9)	Energy (PJ)	PKT (10^9)	Energy (PJ)
Car	urban	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	99.400	
	interurban	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	121.700	
	total	96.169	235.7	155.503	385.5	197.214	494.3	221.100	584.2
Bus	urban	80.141	31.5	149.744	41.2	136.719	75.4	152.505	
	interurban	102.871	39.7	190.060	62.3	241.375	77.1	271.798	
	total	183.012	71.2	339.803	103.5	378.094	152.5	424.603	
Rail	urban	4.080	1.3	13.090	1.8	16.334	2.7	17.623	2.7
	interurban	4.080	3.1	5.759	4.5	5.445	5.8	5.422	5.6
	total	8.160	4.4	18.849	6.3	21.778	8.5	23.045	8.3
Air	total	4.080	37.7	8.901	65.2	7.259	64.1	10.167	84.5
Total		**291.4**	**349.0**	**523.1**	**560.5**	**604.3**	**719.4**	**678.9**	**677.0**

PKT = passenger* km of travel
PJ = peta-joules (10^15 J)
Source: Scheinbaum, Meyers, and Sahaye, 1994 (Ref 2.2)

Table 2.8 Total energy consumption by mode and fuel type in Mexico ($10^{15}J$)

Mode	Fuel	1975		1983		1988		1990	
		PJ	%	PJ	%	PJ	%	PJ	%
Autos	Gasoline	235.7	36.5%	386.0	37.6%	494.4	43.8%	583.9	43.5%
	LPG	6.5	1.0%	7.2	0.7%	11.3	1.0%	13.4	1.0%
Buses	Gasoline	25.8	4.0%	31.8	3.1%	56.4	5.0%	n/a	n/a
	Diesel	43.3	6.7%	66.7	6.5%	84.7	7.5%	n/a	n/a
	LPG	2.6	0.4%	5.1	0.5%	12.4	1.1%	n/a	n/a
Trucks	Gasoline	116.9	18.1%	204.3	19.9%	162.5	14.4%	n/a	n/a
	Diesel	136.3	21.1%	211.5	20.6%	190.8	16.9%	n/a	n/a
	LPG	1.3	0.2%	4.1	0.4%	11.3	1.0%	n/a	n/a
Maritime	Diesel	5.2	0.8%	12.3	1.2%	16.9	1.5%	21.5	1.6%
	Fuel Oil	5.8	0.9%	5.1	0.5%	4.5	0.4%	5.4	0.4%
Air	Gasoline	1.9	0.3%	3.1	0.3%	2.3	0.2%	2.7	0.2%
	Jet fuel	33.6	5.2%	58.5	5.7%	57.6	5.1%	75.2	5.6%
Rail	Diesel	28.4	4.4%	27.7	2.7%	23.7	2.1%	26.8	2.0%
	Electric	1.3	0.2%	2.1	0.2%	2.3	0.2%	2.7	0.2%
Total		645.85	99.8%	1026.6	99.9%	1128.7	100.2%	1342.4	54.5%
Differ.	(PJ)	1.3		1.0		-2.3		n/a	

Source: Scheinbaum, Meyers, and Sahaye, 1994 (Ref 2.2)

Tables 2.9 and 2.10 were obtained from the Instituto Mexicano del Transporte (Ref 2.1). Table 2.9 shows total energy consumption disaggregated by mode, including both freight and passenger. Table 2.10 shows energy consumption data by fuel type. Table 2.11, obtained from the Mexican Secretariat of Mining and Industry (Ref 2.6), contains data on fuel consumption by passenger cars only, along with a forecast of future trends. The percentages shown in these tables are with respect to total consumption.

Table 2.9 Energy consumption by mode in Mexico ($10^{15}J$)

Mode	1980	1985	1986	1987	1988	1989	1990	1991
Auto Bus Truck	902.00 87.3%	979.90 89.5%	976.13 89.7%	991.205 88.9%	1022.19 90.5%	1121.44 90.0%	1207.70 89.9%	1304.44 91.1%
Air	60.30 5.8%	66.16 6.0%	64.07 5.9%	65.33 5.8%	59.05 5.2%	69.51 5.6%	77.47 5.8%	80.40 5.6%
Rail	41.46 4.0%	26.38 2.4%	24.29 2.2%	34.76 3.1%	23.45 2.1%	29.31 2.3%	28.06 2.1%	23.45 1.6%
Maritime	27.69 2.7	20.52 1.9%	20.99 1.9%	21.36 1.9%	21.36 1.9%	23.03 1.9%	26.80 2.0%	20.94 1.5%
Electric*	1.68 0.2%	2.51 0.2%	2.51 0.2%	2.51 0.2%	2.93 0.3%	2.93 0.2%	2.51 0.2%	2.93 0.2%
TOTAL	1033.08 100%	1095.48 100%	1088.36 100%	1115.58 100%	1128.98 100%	1246.23 100%	1342.55 100%	1432.16 100%

*Cable cars and other urban electric vehicles
Source: Instituto Mexicano del Transporte, 1991 (Ref 2.1)

Table 2.10 Energy consumption by fuel type ($10^{15}J$)

Fuel	1980	1985	1986	1987	1988	1989	1990	1991
Gasoline	620.60 59.8%	638.19 58.0%	654.94 59.9%	685.93 61.3%	714.40 63.1%	803.60 64.0%%	884.00 65.8%	952.26 66.5%
Diesel	331.66 32.0%	324.96 29.6%	307.37 28.1%	310.30 27.7%	302.76 26.7%	320.77 25.7%	342.55 25.5%	363.06 25.3%
LPG	6.70 0.6%	48.16 4.4%	44.39 4.0%	35.59 3.2%	34.76 3.1%	36.43 2.9%	15.91 1.2%	16.75 1.2%
Kerosene	59.88 5.8%	64.07 5.8%	61.56 5.6%	63.23 5.7%	56.95 5.0%	67.42 5.4%	75.80 5.6%	78.31 5.5%
Fuel Oil	12.98 1.3%	17.17 1.6%	18.01 1.7%	17.58 1.6%	17.17 1.5%	18.43 1.5%	21.78 1.6%	18.43 1.3%
Electricity	1.68 0.2%	2.51 0.2%	2.51 0.2%	2.51 0.2%	2.93 0.3%	2.93 0.2%	2.51 0.2%	2.93 0.2%
TOTAL	1037.27 100%	1099.25 100%	1092.55 100%	1119.76 100%	1133.17 100%	1250.42 100%	1342.55 100%	1432.16 100%

Source: Instituto Mexicano del Transporte, 1991 (Ref 2.1)

Table 2.11 Fuel consumption by passenger cars

	YEAR				
	1987	**1992**	**1997**	**2002**	**2007**
Number of Autos (10^3)	5,042	6,639	8,973	10,820	13,015
Energy Use (10^{15}J)	587.77	773.91	993.68	1256.66	1625.54
Energy Demand Growth	n.a.	5.7%	5.1%	4.8%	5.3%

Source: Vieyra Fernandez (Ref 2.6)

Data on upstream energy in Mexico are available only from the Instituto Mexicano del Transporte (Ref 2.1) and are aggregated for all economic sectors. Table 2.12 compares total upstream energy use, transportation energy use, and total energy use in all sectors (upstream plus end use). In 1991, transportation energy use was almost 36 percent of the total, while upstream energy use was 10.3 percent of the total. Historically, transportation energy consumption has varied between 31 and 36 percent of the total, with upstream energy consumption varying between 7 and 13.5 percent of the total.

Table 2.12 Upstream energy consumption in Mexico

	Year			
Sector	**1980**	**1985**	**1990**	**1991**
Transportation	1033.08	1095.48	1342.55	1432.16
Upstream energy (total)	229.48	417.92	412.48	410.39
Total energy	2973.20	3535.18	3854.27	3994.97

Data Discussion

Before using the data to discuss the Mexican energy consumption trends, we need to point out some discrepancies found within the three data sources. In the data presented by the Berkeley Laboratories (Ref 2.2), the reported disaggregated amounts do not add up to the total energy consumption. While the magnitude of this difference is never more than 2 percent, still, it is the same magnitude as the energy consumption observed in several modes and fuel types. For example, in Table 2.8, the observed 1988 percent shares add up to 100.2 percent of the reported total consumption. This -2 percent difference is either greater than or almost equal to the reported energy consumption for electric trains, diesel trains, LPG (all modes), and waterborne transport.

In terms of the differences among sources, a direct comparison of all figures presented by all sources is not possible, owing to differences in data disaggregation by year and by other categories. However, Table 2.13 compares 1988 data from the Berkeley Laboratories report (Ref 2.2) with data from the Instituto Mexicano del Transporte report (Ref 2.1) by mode and fuel type.

Table 2.13 Comparison between two data sources (1988 data)

Category	SCT-IMT (Ref 2.1)	Berkeley (Ref 2.2)	Difference
Mode			
Auto, Bus and Truck	1022.19	1012.44	1.0%
Air	59.05	59.82	-1.3%
Rail	23.45	25.96	-10.7%
Maritime	21.36	21.45	-0.4%
Fuel			
Gasoline	714.40	715.60	-0.2%
Diesel	302.76	316.04	-4.4%
LPG	34.76	34.99	-0.7%
Fuel Oil	17.17	4.51	73.7%
Jet fuel	56.95	57.56	-1.1%
Electric	2.93	2.26	23.0%

Difference is calculated as Ref 2.2 with respect to Ref 2.1.

The Berkeley Laboratories report (Ref 2.2) draws heavily from the other two sources; hence, it is no surprise that several values are in agreement. Nevertheless, the values for rail, waterborne fuel oil, and electric vehicles are in significant disagreement. Sources consulted in Mexico consider the Instituto Mexicano del Transporte the most reliable source of transportation data. The Berkeley Laboratories report does not comment on the reliability of sources used in the preparation of their document. No source explains how its estimates were obtained.

There are two basic methods used to calculate energy consumption in the transportation sector. One is through fuel sales data, and the other is through vehicle-kilometers of travel (VKT) and vehicle economy. The reliability of the second method depends on the accuracy of estimates of both VKT and vehicle economy, while the first method is apparently less dependent on data that are intrinsically fuzzier than sales reports. On the other hand, fuel sales do not necessarily correspond to fuel actually utilized in transportation, especially in a region that exports oil and oil products (i.e., both Texas and Mexico). Although we know for certain that our source of Texas energy data is not based on fuel sales data, the methods of calculation used for Mexican data are not reported; those methods could, therefore, be the basic reason for the observed discrepancies among sources.

Regardless of the uncertainties just discussed, the data clearly indicate that the Mexican transportation sector remains dominated by gasoline and diesel fuels, as well as by highway-related transportation. Figures 2.2 and 2.3 illustrate this important point. Automobiles are responsible for 30 to 45 percent of the transportation energy consumption, depending on the year and data source. All sources indicate that the share of energy utilized by automobiles has been increasing with time. Air transport consumes about half of the energy used by buses, and bus share has been increasing with time. And while the air transport share has remained between 5 and 6 percent, total air transport consumption has increased with time, especially in 1990 and 1991. Waterborne transport share of energy consumption has also remained constant; the share of rail has been steadily decreasing. The latter does not coincide with an improvement in rail efficiency; rather, the multimodal data presented in the previous chapter clearly indicate that this decrease in energy use is due to a decline in overall railway utilization. The Mexican government is now privatizing much of its rail system in an attempt to improve rail efficiency and to encourage use of this efficient transport mode in Mexico.

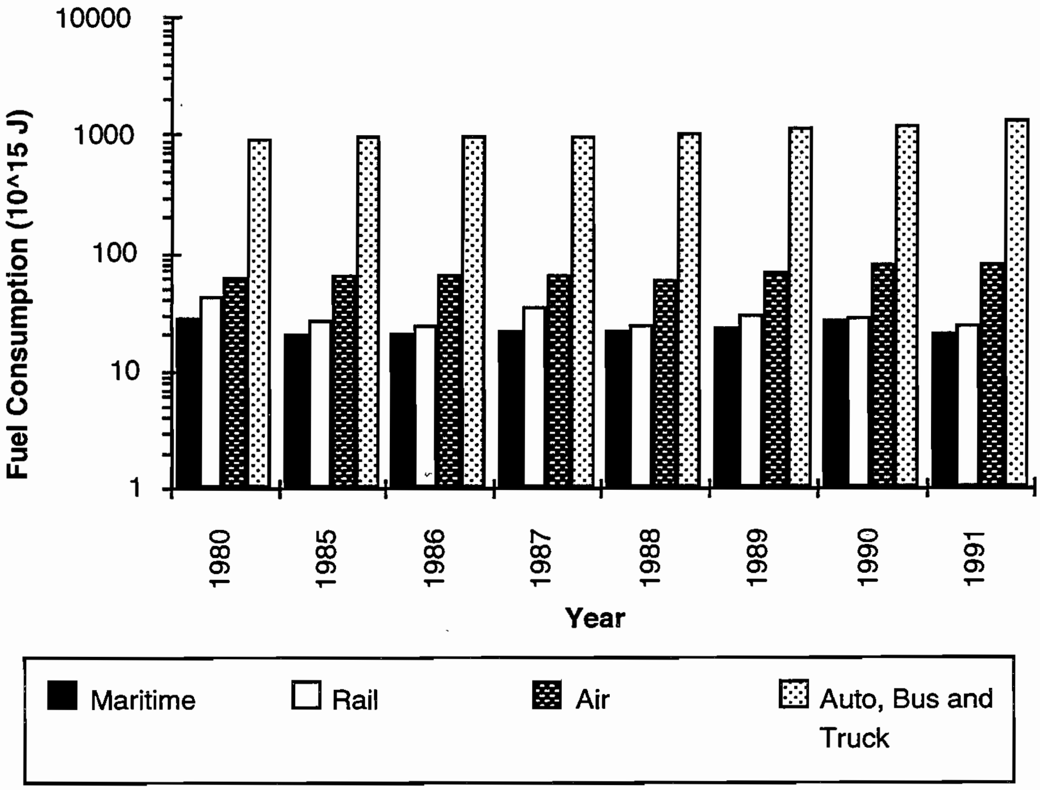

Figure 2.2 Energy consumption in Mexico by mode of transportation (Source: Ref 2.1)

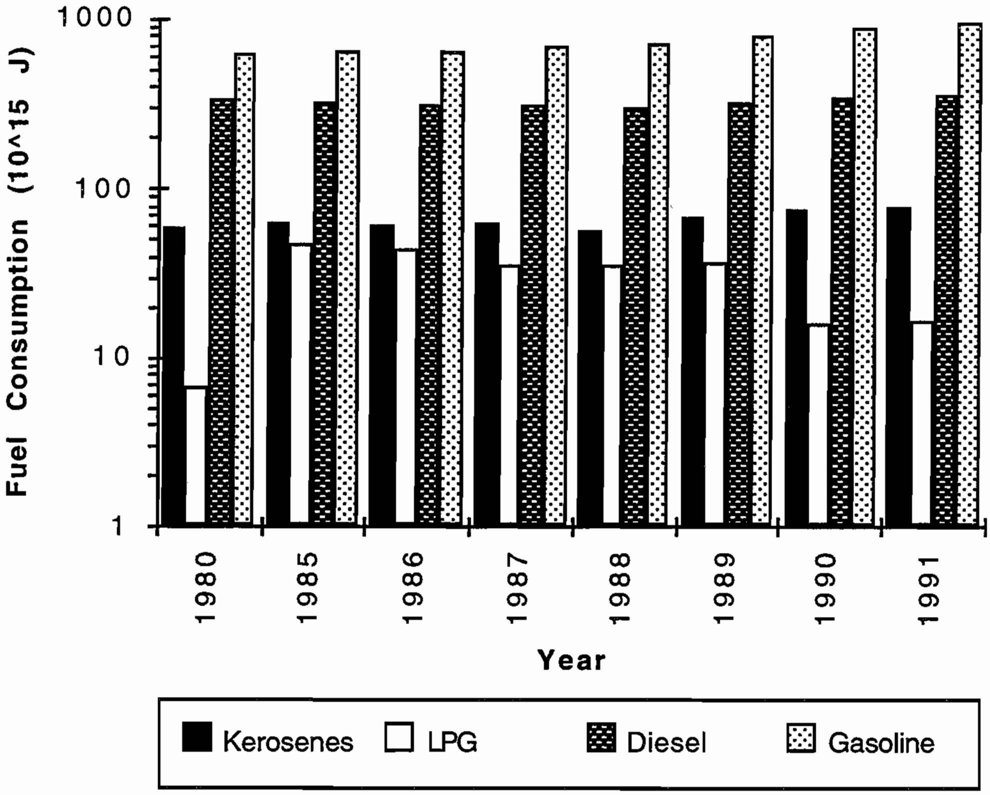

Figure 2.3 Energy consumption in Mexico by type of fuel (Source: Ref 2.1)

SUMMARY AND CONCLUSIONS

The Mexican and Texas data show marked differences in energy use, basically reflecting Texas' higher reliance on low-occupancy automobiles and on air, rail, and maritime transport. In 1990, Mexican autos, buses, and trucks consumed around 90 percent of the fuel, airplanes 6 percent, and rail and water around 2 percent each. In Texas, autos, buses, and trucks are also the prevailing mode in energy consumption, with 68 percent of the total; but unlike Mexico, airborne and waterborne transportation have a significant share of energy consumption (15 percent and 11.5 percent, respectively).

The most important fuels in Texas and Mexico are gasoline and diesel. In Mexico, gasoline represents 67 percent of fuel usage, and diesel 25 percent. In Texas, the percentages were 46 and 24 for gasoline and diesel, respectively. Other types of fuels contributed little to the total usage of energy both in Texas and in Mexico.

The data clearly show that excessive energy consumption in transportation is much more serious in Texas than in Mexico. The energy consumed in Texas in 1994 was 2156 PJ; in Mexico, the entire country used 1432 PJ during 1991. Nevertheless, the Mexican data indicate a trend towards a less efficient transportation system, with increased reliance on individual transportation by automobiles and a significant decrease in rail utilization.

Energy consumption is becoming an increasingly important concern of transportation planners. The data collected in this study can assist planners in developing a more efficient and environmentally friendly transport system. We recommend continuous updating of all transportation data; this is even more important in the case of energy use, which is so dependent on the rapidly changing transportation policies related to air quality and multimodalism. Future projections need to be verified and periodically updated, since the transportation policies used to obtain the projections may shift in the future.

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CHAPTER 3. MEXICAN TRUCK WEIGHTS

SIGNIFICANCE OF THE DATA

Among the important provisions of the North American Free Trade Agreement (NAFTA) is the liberalization of truck traffic moving throughout the NAFTA territory (Ref 3.4). Before NAFTA, foreign trucks were required to remain within the commercial zone of both countries (a rather narrow strip along the border). This created a need for switching trucks at the border, a need that is often served by drayage companies specialized in hauling cargo from one side of the border to another. This procedure remains the primary cause of the high percentages of empty trucks — 35 to 40 percent on average — observed throughout the border (Refs 3.9–3.11). This inefficient procedure adds to the problems (discussed in the previous chapter) relating to the amounts of energy used by the Texas transportation sector.

The NAFTA liberalization of truck traffic thus has the potential to decrease the number of trucks crossing the border. However, Texas' regulations governing truck weight limits are more restrictive than those of both Mexico and Canada. Consequently, harmonization of truck weight limits has emerged as a controversial issue within the NAFTA agenda: On the one hand, heavier trucks cause more pavement damage; on the other hand, fewer trucks are needed to carry the same load, thus decreasing congestion.

Paramount to resolving these harmonization issues is the availability of truck weight data. TxDOT already has impressive statewide coverage of weigh-in-motion stations, some of them installed at the Mexican border (Ref 3.6). In this study, we collected data about a nationwide truck weight survey in Mexico. The results of this survey supplement TxDOT's weigh-in-motion data, allowing comparisons of the weights of trucks operating both on the border and within Mexico.

BACKGROUND

Since 1960, the government of Mexico has modified federal regulations regarding truck size and weight three times — in 1960, 1980, and in 1993 (Refs 3.1–3.3). The 1980 regulation was motivated by the economic crisis that deeply affected the freight sector; consequently, it was less strict than the 1960 regulation. The 1993 regulation was prompted by the pavement damage, bridge damage, and safety problems resulting from low truck weight limits and inadequate enforcement (Ref 3.5). Detailed information about the 1993 Mexican truck weight regulation is important for transportation planning, since weight limits change during the transition time leading up to the final weight limitations to be implemented in 1996. An English translation of the 1993 Mexican truck weight regulation can be obtained from TxDOT's International Relations Office.

All three regulations refer to a truck classification designated by an alphanumeric code, and to a one-letter highway classification. The types of trucks did not change from regulation to regulation, although new truck types have been added. Mexican truck classifications are depicted in Figure 3.1.

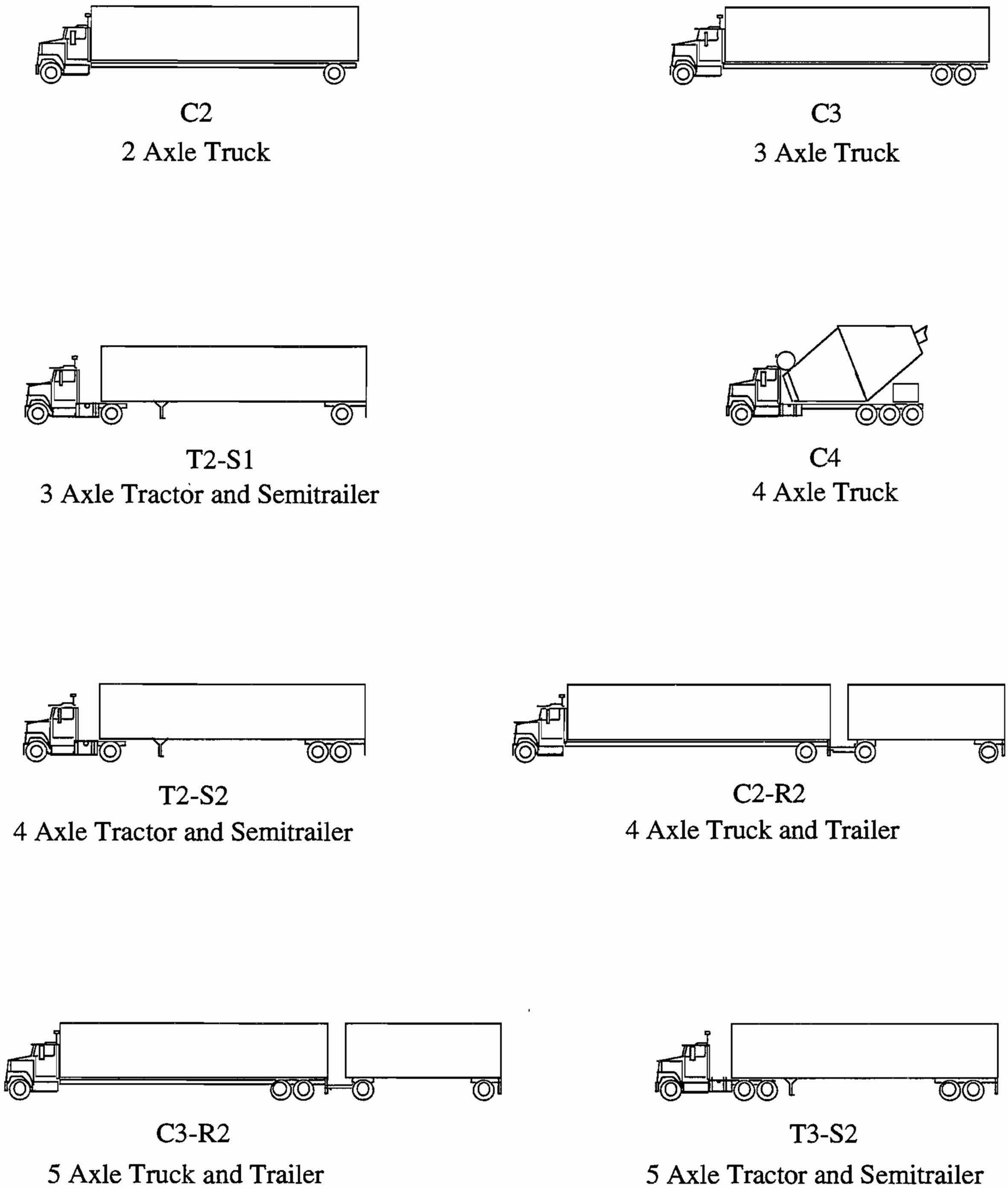
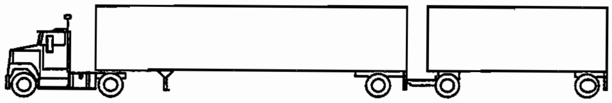
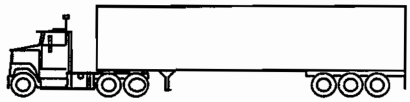


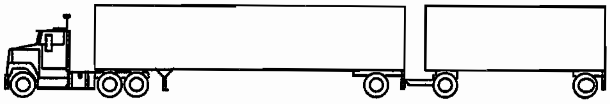
Figure 3.1 Mexican truck classifications



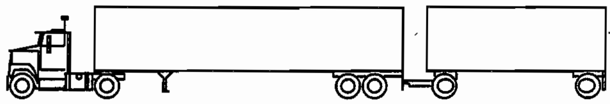
T2-S1-R2
5 Axle Tractor, Semitrailer, and Trailer



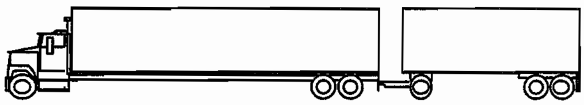
T3-S3
6 Axle Tractor and Semitrailer



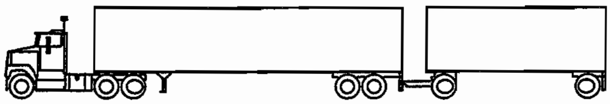
T3-S1-R2
6 Axle Tractor, Semitrailer, and Trailer



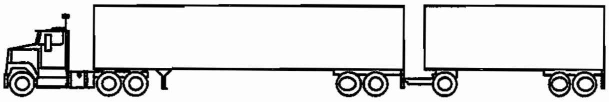
T2-S2-R2
6 Axle Tractor, Semitrailer, and Trailer



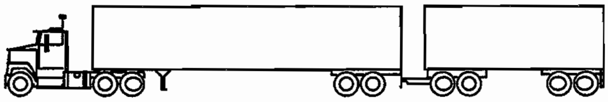
C3-R3
6 Axle Truck and Trailer



T3-S2-R2
7 Axle Tractor, Semitrailer, and Trailer



T3-S2-R3
8 Axle Tractor, Semitrailer, and Trailer



T3-S2-R4
9 Axle Tractor, Semitrailer, and Trailer

Figure 3.1 (Continued) Mexican truck classifications

Overview of Mexican Truck Regulations

The 1960 regulation, which classified the trucks as shown in Figure 3.1, included only C2, C3, T2-S1, T2-S2, T3-S1, C2-R2, T3-S2, and C3-R2. Highways were classified as either A, which carries all trucks, or B, which does not serve T3-S2 and C3-R2. Bridge damage was controlled through an additional weight restriction that depended on the distance between the axles (Ref 3.1).

The 1980 regulation expanded the highway classes to three, eliminated the bridge damage control, and increased the truck weight limits (the latter shown in Table 3.1). The 1980 regulation was more tolerant in terms of truck sizes and heights because it resulted from the 1980 economic depression, which heavily affected the freight sector. Motor carriers requested and obtained a less strict truck regulation (Ref 3.2).

During the 1980s, two major problems were observed regarding truck size and weight regulations: lack of adequate enforcement, and an inconsistency between the highway classes and the allowed truck sizes and weights. The result was accelerated pavement and bridge damage and an increase in traffic safety hazards (Ref 3.5).

Objectives and Overview of the 1993 Regulation

The 1993 regulation sought to ameliorate these problems and to provide motor carries a 3-year adjustment period, during which time the weight limits rose until they reached a lower final limit. The inconsistencies between highway classes and truck size and weight limits were tackled by redefining the allowed truck weights, and defining four highway classes, A to D. Class A highways handle the heaviest trucks, while class D highways have the strictest constraints. The Mexican government expects to enforce the regulation by installing truck scales on all major highways, and by requiring truck manufacturers to provide loading specifications (Ref 3.5).

The 1993 regulation will include a relationship between gross weight and distance between axles, to control bridge damage. This provision existed in 1960 but was eliminated in 1980. The 1960 regulation had only one bridge formula relating the maximum gross weight to the distance between first and last axles. The 1993 regulation specifies one formula for each highway class. Equation 3.1 illustrates the formula for class A highways (Ref 3.5).

$$MGW = 899.4 \left(\frac{DE * N}{N - 1} + 3.66 N + 11 \right) \qquad \text{(Eq 3.1)}$$

where:

MGW = maximum gross weight permitted in bridges (kg),

DE = distance between first and last axles (m), and

N = number of axles between the first and last axles.

The 1993 regulation also included new and stricter insurance and vehicle licensing requirements, a sliding scale of fines, provisions for enforcement of the regulation, and a 5 percent tolerance in weight limits (Ref 3.5). Table 3.1 summarizes the evolution of Mexican truck weight regulations. The boldface values in Table 3.1 are restricted through Equation 3.1. In these cases, the bridge formula overrides the axle weight limits defined to control pavement damage (Ref 3.5).

Table 3.1 Evolution of Mexican truck weight regulations

Truck Type	Regulation								
	1960		1980			1993			
	Highway Class								
	A	B	A	B	C	A	B	C	D
C2	14.0	13.7	15.5	14.0	12.0	16.5	16.5	14.0	12.0
C3	19.5	18.6	23.5	20.0	18.0	24.5	24.5	21.0	18.0
C4	-	-	28.0	-	-	-	-	-	-
T2-S1	23.0	22.4	25.5	23.0	-	26.5	26.5	23.0	20.0
T2-S2	28.5	27.3	33.5	29.0	-	34.5	34.5	30.0	26.0
T3-S1	28.5	27.3	-	-	-	-	-	-	-
T3-S2	34.0	31.0	41.5	35.0	-	**42.5**	**42.5**	**37.0**	**32.0**
T3-S3	-	-	46.0	-	-	**47.0**	**47.0**	**41.0**	**36.0**
C2-R2	32.0	31.0	35.5	-	-	36.5	36.5	**32.0**	**27.0**
C3-R2	34.0	31.0	43.5	-	-	**44.5**	**44.5**	**39.0**	**34.0**
C3-R3	-	-	51.5	-	-	**52.5**	**52.5**	**46.0**	**35.0**
T2-S1-R2	-	-	45.5	-	-	46.5	**43.0**	**36.0**	**28.0**
T3-S1-R2	-	-	53.5	-	-	**54.0**	**46.0**	**40.0**	**30.0**
T3-S2-R2	-	-	61.5	-	-	**58.0**	**48.0**	**42.0**	**31.0**
T3-S2-R3	-	-	69.5	-	-	-	-	-	-
T3-S2-R4	-	-	77.5	-	-	**62.0**	**52.0**	**44.0**	**34.0**

The 1993 Mexican truck weight regulation provided a 3-year period for the motor carrier industry to adapt to the stricter sizes and weights. During this period, some of the limits will be higher than the final ones to be enforced starting November 1, 1996. Table 3.2 compares the various stages of the 1993 regulation and the Texas regulation, for selected truck types, and Mexican highways class A.

Table 3.2 Comparison between Mexican and Texas regulations

Truck Type	New Mexican Regulation			Texas Regulation
	1993	1994-1995	11/1/96	
C2	16.5	21	17.5	18.2
C3	24.5	30	26	24.5
T3-S2	42.5	51	44	40
T3-S3	47	63	48.5	43.6
T3-S3-R4	62	77	65.5	70.9

DATA DESCRIPTION

The truck weight data discussed in this chapter were collected for a truck size and weight study developed by the Instituto Mexicano del Transporte (IMT). The broad objectives of the IMT study are related to infrastructure management, with the data expected to be used to evaluate pavement and bridge damage and to establish priorities for rehabilitation and maintenance.

Data Sources and Scope

In its study titled "Economic Impacts of the 1993 Weight Regulation," IMT evaluated the socioeconomic impacts of the new size and weight limits using data collected under the broader "Study of Size and Weights of Vehicles Using the National Highways" (Ref 3.5). The data were collected through the Dirección General de Proyectos, Servicios Técnicos y Concesiones (DGPSTyC) (Ref 3.10). Both DGPSTyC and IMT are subdivisions of the Mexican Secretaría de Comunicaciones y Transportes (SCT). The data consist of information from 10 truck weighing stations, which operated four consecutive days in 1991. Truck weight data are supposed to be collected every year, and the number of truck weight stations is supposed to increase (Ref 3.5). Figure 3.2 shows the locations of these first 10 data collection stations, while Table 3.3 depicts the number of trucks surveyed in each station, as well as the location of each station.

Table 3.3. Truck weight survey — scope and stations locations

No	Station	Trucks Surveyed
1	Amozoc, Puebla Puebla-Córdoba, Km 9+000	2,945
2	Hermosillo-Sta. Ana, Km 8+900	10,044
3	Zacatecas-Durango, Km 18+000 near Zacatecas	11,052
4	Querétaro (toll road) Km 81+000 after Salamanca	7,511
5	México-Querétaro (toll road) Km 43+010 after Tepotzotlán	25,503
6	México-Puebla (toll road), Km 34+000 after San Marcos toll booth	11,578
7	Monterrey-Nuevo Laredo, Km 20+190 near Monterrey	11,735
8	Querétaro-S L Potosí, Km 28+530 near San Miguel Allende	15,791
9	Tulancingo-Tuxpan, Km 154+940 near Tajín	8,375
10	Córdoba-Veracruz, Km 33+520 near Tinaja	12,827
	TOTAL =	**117,361**

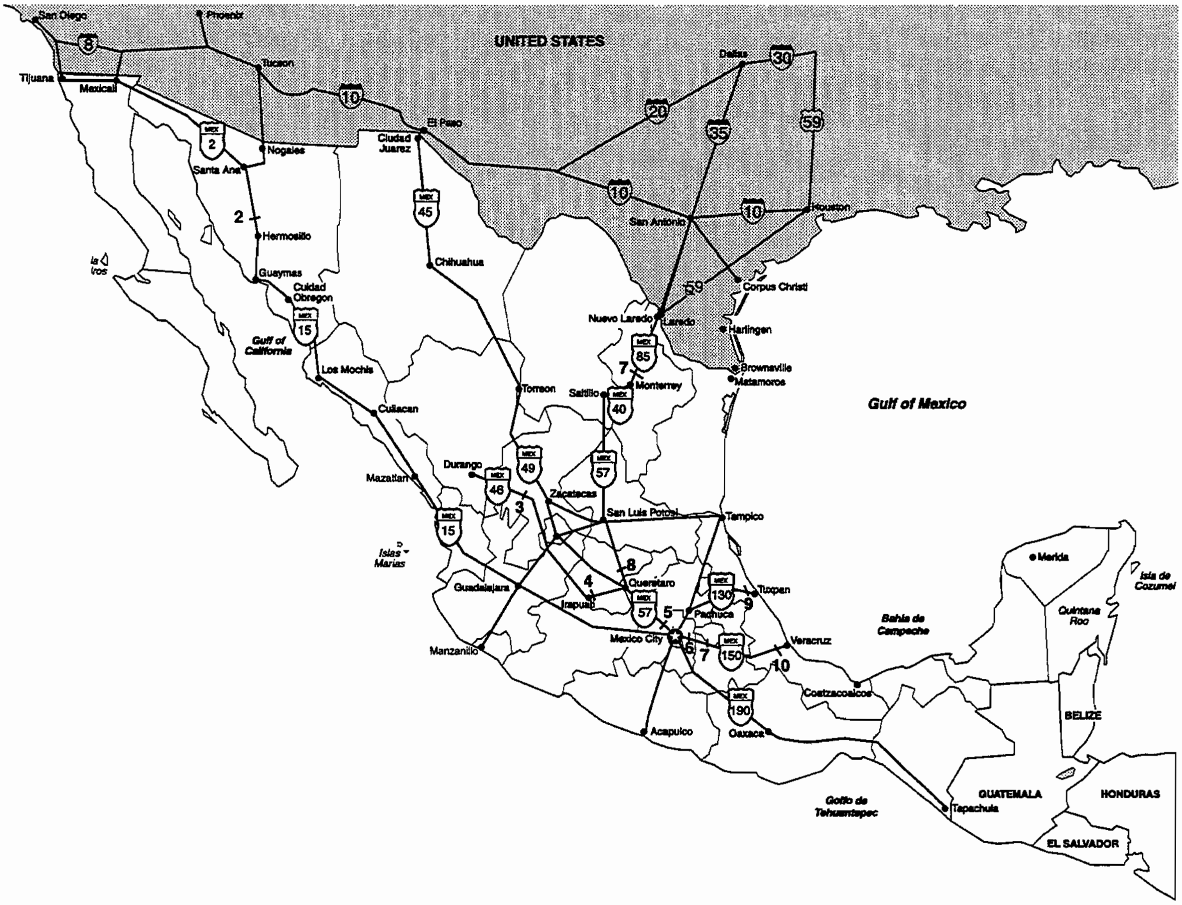


Figure 3.2 Locations of the truck weight survey stations

The data collected include the truck weights and their classification according to Table 3.1. The total number of trucks sampled was 117,361. However, 18,374 trucks were omitted from the study because their weights showed inconsistency, being either too large or too small for the type of vehicle recorded. The remaining 98,986 vehicles represent the sample used for the investigation discussed in this chapter.

Data Organization and Description

Table 3.4 shows the observed number of empty and loaded trucks for each truck type, as well as the percentage of the total sampled. The small trucks (types C2 and C3) total nearly 60 percent of the trucks sampled, while larger trucks, such as the T3-S2-R4, consist of only 3.5 percent of the sample. The percentage of empty trucks is rather large, averaging over 37 percent for all trucks, but increasing to almost 41 percent for small C2 and C3 trucks.

Table 3.4 Truck load distribution

Truck type	Empty	Loaded	Total
C2	16,224 (47.6%)	17,895 (52.4%)	34,119 (36.7%)
C3	7,783 (34.1%)	15,047 (65.9%)	22,830 (21.7%)
T3-S2	7,585 (31.8%)	16,233 (68.2%)	23,818 (23.1%)
T3-S3	4,293 (29.2%)	10,472 (70.8%)	14,720 (14.1%)
T3-S2-R4	416 (37%)	708 (63%)	1,124 (2.0%)
OTHER	892 (37.5%)	1,483 (62.5%)	2,375 (2.4%)
TOTAL	37,193 (37.6%)	61,793 (62.4%)	98,986 (100%)

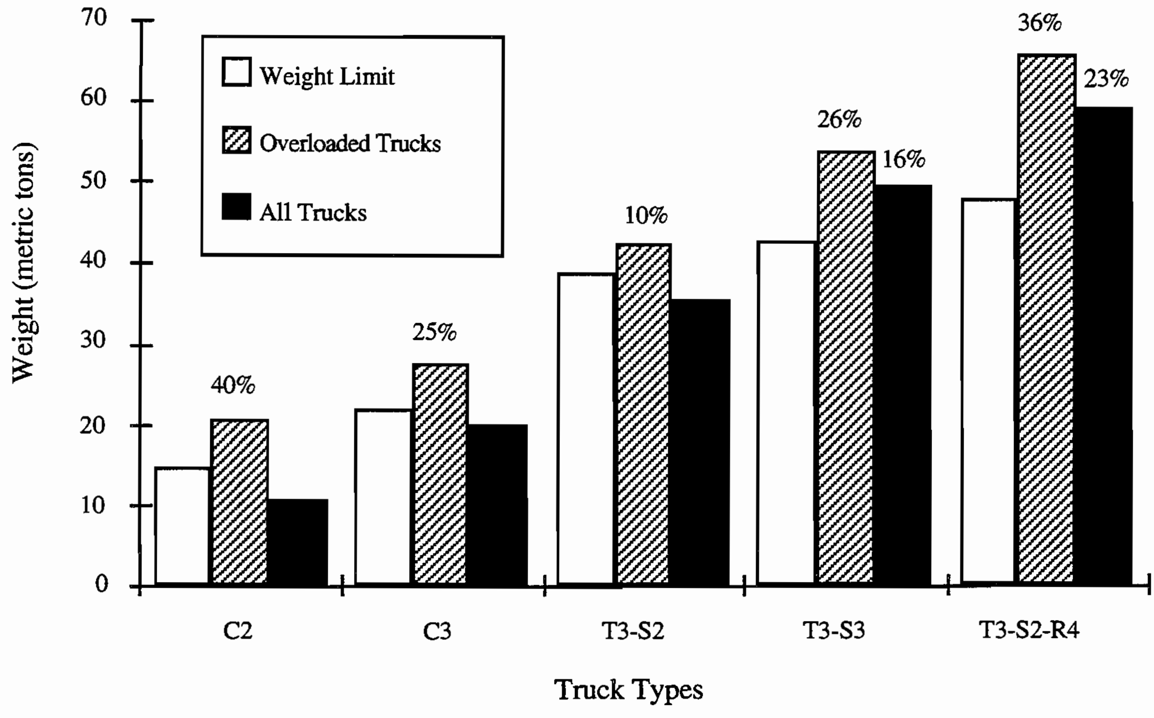
Table 3.5 shows the average truck weights observed for each truck category. Figure 3.3 shows a comparison between weight limits and the observed truck weights, the latter averaged in two ways: overall trucks and overall overloaded trucks. Weight limits were averaged over all four highway classes. Overload amounts vary between 10 and 40 percent above the average weight limit. The average weight of all loaded T3-S3 and T3-S2-R4 trucks is above the limit, indicating

either a high percentage of overloaded trucks or a smaller percentage of trucks with very significant overloads. Both situations are very harmful for pavements, bridges, and other structures.

Table 3.5 Average truck weights

Truck Type	Maximum Weight Class A	Maximum Weight Average	Average Weight (Metric Tons) Empty	Loaded	Overloaded	All Trucks
C2	16.5	14.75	3.84	9.0	20.7	10.7
C3	24.5	22	8.58	16.9	27.6	19.9
T3-S2	42.5	38.5	17.02	29.2	42.3	35.5
T3-S3	47.0	42.75	18.01	30.3	53.7	49.5
T3-S2-R4	62.0	48	29.18	44.4	65.5	59.0

Maximum weights are according to 1993 regulation.



Notes: Weights limits are averaged for all highways classes defined in the 1993 regulation.
Observed weights are averaged for all trucks of each truck type.

Figure 3.3 Comparison of observed weights and weight limits

Table 3.6 shows the percentages of overloaded trucks found in the sample of 98,986 trucks. The overloading was calculated with respect to the 1980 and the 1993 regulations for class

A highways. As expected, the 1993 regulation results in a much higher percentage of overloaded doubles, but a smaller amount of overloaded C2 and C3 trucks. Nevertheless, the overall percent of overloaded trucks is almost the same for both regulations.

Table 3.6 Percentage of overloaded trucks

Truck Type	Regulation			
	1980		1993	
	Percent Of Total	Percent Of Loaded	Percent Of Total	Percent Of Loaded
C2	10.0	19.0	7.8	14.8
C3	23.9	36.2	18.4	27.9
T3-S2	22.7	33.3	23.8	34.9
T3-S3	53.9	76.0	58.3	82.4
T3-S2-R4	6.9	11.0	43.4	68.9
TOTAL	22.3	34.3	22.0	33.3

Source: Ref 3.5.

The IMT also reported the average number of tons-kilometers of travel by truck. Table 3.7 shows the average load, average distance, and ton-km traveled for each type of truck. According to Mendoza and Reséndez, the numbers in Table 3.7 are representative of the entire country (Ref 3.8). Large doubles travel the longer distances; the high percentage of empty trucks of type T3-S2-R4 (shown in Table 3.5) results in the low ton-km for this category.

Table 3.7 Average truck ton-kilometers

Truck Type	Average Load (ton)	Average Distance (km)	Ton-km traveled (millions)
C2	6.9	421	51.9
C3	11.3	566	96.3
T3-S2	18.5	738	221.7
T3-S3	31.5	718	235.5
T3-S2-R4	29.8	726	15.3
TOTAL	15.7	656	620.7

Source: Ref 3.5

DATA DISCUSSION

The IMT report presents an interesting discussion of the impacts of the new regulation on highway traffic, cost of infrastructure maintenance, and costs of truck transport. This section summarizes IMT's conclusions and recommendations.

Impact of Truck Regulation Enforcement on the Total Number of Truck Trips

The IMT evaluated the number of additional truck trips necessary to carry the same freight tonnage without overloading any truck. Table 3.8 presents these results, which consist of additional truck trips necessary to haul the same freight without overloading, and the percent increase. Overloaded trucks shown in Table 3.8 were calculated with respect to the 1980 and 1993 weight limits for class A highways. The percent increase in number of trucks was calculated with respect to the total observed number of trips (loaded, overloaded, and empty trucks). Figure 3.4 compares the impacts of strict enforcement of the 1993 and the 1980 regulations on the number of truck trips, in terms of percent increase with respect to the observed trips.

Table 3.8 Impacts of weight limit enforcement on number of truck trips

Truck Type	1980 Regulation		1993 Regulation	
	Additional Trips	Percent Increase	Additional Trips	Percent Increase
C2	4,608	14	3.519	10.3
C3	6,643	29	5,017	22.0
T3-S2	6,753	28	7,129	29.9
T3-S3	10,330	70	11,984	81.4
T3-S2-R4	80	7	592	52.7
TOTAL	28,414	29	24,726	29.2

Source: Ref 3.5

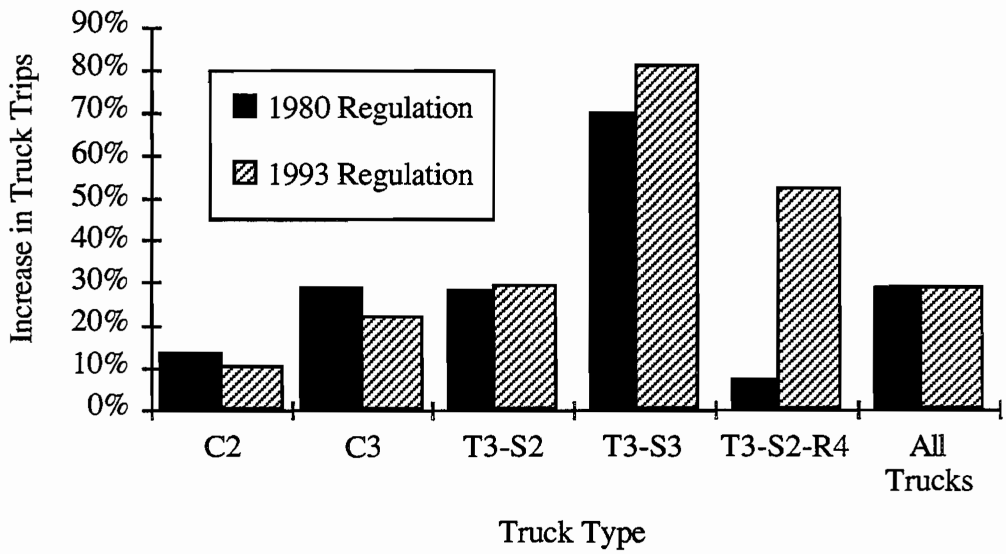


Figure 3.4 Increase in truck trips with enforcement of weight regulations

The values shown in Table 3.8 and Figure 3.4 are very interesting, since they indicate that enforcement of 1980 or 1993 regulations would have the same impact on the total number of truck trips. The greater impact of the 1993 regulation is on the largest truck included in the calculations, namely T3-S2-R4. The greatest impact of enforcing any regulation is on the T3-S3 truck type, which is the second most common type of truck in the sample. The analysis indicated that the new regulation is far better than that of 1980, since it has the advantage of reducing pavement and bridge consumption, with the same increase in total number of trucks on the Mexican highways (Ref 3.5).

Impact of Truck Regulation Enforcement on the Costs of Truck Operation, Infrastructure Maintenance, and Consumer Goods

The IMT compared the increase in operational costs to be expected by the freight industry owing to enforcement of the 1980 and 1993 weight limitations. The data indicated that the only truck types significantly affected by the enforcement of a stricter regulation are T3-S3 and T3-S2-R4, with expected cost increases of 7.9 and 12.2 percent, respectively. Small trucks (C2 and C3) experience a decrease in operational costs, while T3-S2 costs increase only 0.6 percent (Ref 3.5).

A comparison between the increase in truck operational costs and expected decrease in costs of highway maintenance shows the significant advantages of strict enforcement of the 1993 weight regulations. The largest increase in vehicle operational costs caused by enforcement of the 1993 regulation is 12.2 percent, while the overall decrease in highway maintenance is 33 percent (Ref 3.5).

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The Mexican truck weight survey indicates a tendency to overload trucks as much as 40 percent above the limit for some truck classes. The most significant violations of weight limits occur for truck classes C2 and C3, which are the smallest trucks. On the average, trucks types T3-S3 and T3-S2-R4 (the largest truck individually specified) exceeded weight limits by 26 and 36 percent, respectively.

In estimating the impacts that an increase in transportation costs would have on the prices of consumer goods, the IMT found those increases to be very small, especially when compared to the savings in infrastructure maintenance. Given these findings, IMT recommends immediate implementation and strict enforcement of the 1993 regulation. However, the costs of strict regulation enforcement are not included in the IMT analysis (Ref 3.5).

The IMT estimated the number of additional truck trips necessary to carry the same freight tonnage without overloading any truck. The analysis indicated that the new regulation is far better than the 1980 regulation, since it has the advantage of reducing pavement and bridge consumption while increasing only slightly the total number of trucks on Mexican highways (Ref 3.5). The IMT findings provide insight into the potential for accepting Mexican and/or Canadian truck weights on Texas highways. Would this acceptance result in a negligible decrease in the overall number of truck trips, analogous to those found by IMT when comparing the 1980 and 1993 regulations? If so, this would militate against heavier trucks, since more infrastructure damage would not be offset by fewer trucks on Texas highways. It is worth noting that the percent of empties found in the Mexican survey is similar to that observed along the Texas-Mexico border.

NAFTA's truck load harmonization provisions seek to streamline border crossing operations and to improve economies of scale. Heavier trucks have a negative impact on pavements and bridges, but presumably a positive impact on highway levels of service, since fewer trucks are needed to haul the same amount of freight. On the other hand, heavier trucks are more efficient to operate, have better economies of scale, and therefore may divert some of the current rail demand. Most studies being undertaken at the moment concentrate on the infrastructure damage caused by heavier trucks. We contend that this is only part of the problem. Accordingly, we recommend a comprehensive two-phase study that would, first, investigate whether the potential decrease in number of trucks would be offset by the new demand created by modal shifts. The second phase of the study should then investigate whether the improvement of highway levels of service resulting from a decrease in number of trucks results in savings sufficient to offset the costs of bridge and pavement upgrades for pre-selected heavy-load or NAFTA corridors. Because these studies would assist TxDOT in dealing with truck load harmonization issues, they are strongly recommended. Since SCT intends to continue the truck weight data collection on a yearly basis, we recommend that TxDOT follow up on the subsequent data updates and use them to supplement its other studies regarding the potential impacts of heavy trucks on the state's transportation infrastructure.

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CHAPTER 4. MULTIMODAL TRANSPORTATION IN TEXAS AND MEXICO

INTRODUCTION, OBJECTIVE, AND SCOPE

Motorists in Texas' urban areas confront congestion on a regular and growing basis. Nationwide, it is estimated that congestion costs consumers between $30 billion and $100 billion annually (Refs 4.1, 4.2). This strain on the system, coupled with the decay in the nation's infrastructure, has created a near-crisis situation. Recognizing this challenge, the federal government's Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has sought a national intermodal transportation system that consists

> ...of all forms of transportation in a unified, interconnected manner, including transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nation's preeminent position in international commerce. (Ref 4.3)

This challenge is considerably more complex when focusing on the Texas-Mexico border region. For example, at the Texas-Mexico border, transborder mobility demands have been addressed by expanding the international bridge network, with little regard to the total social costs of this investment decision, to the overall efficiency of all procedures involved in crossing an international border, or to the ratio of this investment that would benefit other states that ship their imports and exports through Texas (but who may not assist in funding the infrastructure).

All this indicates a need for multimodal border transportation planning. Prompt availability of up-to-date transportation data on modes other than highway is instrumental for implementing a dynamic transportation planning approach and to demonstrate the need to fund the nation's import/export corridors that utilize Texas' infrastructure.

This chapter documents the multimodal data added to the TRANSBORDER data base under Project 2932. These data consist of Texas and Mexico air transport data, Mexican rail data, and Mexican maritime data. Air transport data for Texas were obtained from origin and destination surveys used by airlines to study their potential markets. They complement the air data routinely collected by the Federal Aviation Administration (FAA, Ref 4.9) and the Civil Aeronautics Board (CAB, Ref 4.12). Rail and maritime data discussed in this chapter are collected by Mexican agencies to serve transportation planning in Mexico; they include detailed information about international commerce that supplements data routinely available from USDOT's Maritime Administration (MARAD, Refs 4.10, 4.11) and the American Association of Railroads (AAR, Refs 4.13, 4.14). Detailed rail data are especially difficult to obtain in the U.S., given that rail transportation is privately owned and most information not published by the American Association of Railroads is considered proprietary (Refs 4.13, 4.14). The Mexican data on rail imports and exports fill this gap, assisting TxDOT in its multimodal transportation efforts and providing insight into the share of Texas rail ports serving NAFTA commerce.

TEXAS AIR TRANSPORT DATA

Air transport data, generally available in terms of number of emplanements and deplanements at major airports, can be obtained from FAA and CAB (Refs 4.9, 4.12). For transportation planning purposes, this type of data documentation has two major limitations:

(1) lack of origin and destination information, and

(2) no discrimination between actual departures/ arrivals, and emplanements/ deplanements due to plane changes.

The air transport data collected in this project contain expanded origin and destination information for all major airports in Texas, including Houston (Intercontinental and Hobby), Dallas (D/FW and Dallas), Austin, San Antonio, Amarillo, Laredo, Abilene, Tyler, and others. The data period is 1991 to 1995, the latter up to September. The data files were constructed using USDOT's data bases DBIA and T100, which include origin and destination surveys results. They are routinely used by airlines in their market share studies, and were obtained with assistance from airline personnel.

Data Description

The air transport data are stored in five spreadsheet-based data sets, one for each year (1991 through 1995). These data sets were named PLANE91 through PLANE95; the last two digits in the data set name indicate the corresponding year. The four data sets have the data fields depicted in Table 4.1.

Table 4.1 Contents of Texas air transport data sets

Field Name	Available	Meaning
AIRPT1	All years	IATA[1] code for airport of origin/destination (e.g., AUS=Robert Miller Airport in Austin, Texas)
AIRPT2	All years	IATA[1] code for airport of origin/destination
PASS	1991 to 1993	Average daily number of passengers traveling between AIRPT1 and AIRPT2 (two-way, starting at either airport)
PASS1	1993 to 1995	Average daily number of passengers traveling between AIRPT1 and AIRPT2 (two-way, AIRPT1 as starting point)
PASS2	1993 to 1995	Average daily number of passengers traveling between AIRPT1 and AIRPT2 (two-way, AIRPT2 as starting point)
TYPE	All	Type of trip (I=international, D= domestic)

[1] International Air Transport Association

Fields AIRPT1 and AIRPT2 have character variables of length 3 that contain the International Air Transport Association (IATA) code for the airport. For example, the city of Houston has two airports, with IATA codes HOU (Houston Hobby, domestic only) and IAH (Intercontinental). The variable PASS is the average daily number of passengers traveling between the two airports. TYPE is a trip type indicator for domestic or international trips.

Beginning in 1994, directional information has also been provided. Data sets PLANE94 and PLANE95 have two numeric variables, PASS1 and PASS2. PASS1 is the two-way traffic volume with AIRPT1 as starting point. PASS2 is the two-way traffic volume with AIRPT2 as the starting point. The sum of PASS1 and PASS2 is equivalent to the variable PASS in the earlier data sets. Tables 4.2 and 4.3 depict samples of each type of data set.

Table 4.2 Sample of Texas air transport data (1991)

PASS	TYPE	AIRPT1	AIRPT2
0.34000	International	AAL	DFW
0.11000	International	AAL	SAT
0.07000	International	AAL	SPS
0.30000	International	AAO	AUS
0.56000	International	AAR	DFW
0.09000	Domestic	ABE	ABI
0.11000	Domestic	ABE	ACT

NOTE: Data sets for years 1992 and 1993 are analogous to PLANE91 (10,056 rows).

Table 4.3 Sample of Texas air transport data (1995)

PASS1	PASS2	TYPE	AIRPT1	AIRPT2
0.03000	0.14000	Domestic	ABE	ABI
0.54000	0.75000	Domestic	ABI	ABQ
0.01000	0.01000	Domestic	ABI	ABY
0.01000	0.01000	International	ABI	ABZ
0.05000	0.05000	International	ABI	ACA
0.07000	0.18000	Domestic	ABI	ACT
0.17000	0.21000	Domestic	ABI	AGS

NOTE: Data set for year 1994 is analogous to PLANE95 (11,502 rows).

Data Discussion

Dallas and Houston have the two largest airports in Texas (plus two other smaller airports), which together serve 75 percent of all air passenger movements. Austin and San Antonio together serve another 15 percent, while the remaining 10 percent are served by all other Texas airports combined. Figure 4.1 depicts the 1995 share of Dallas, Houston, San Antonio, Austin, and all other Texas cities combined.

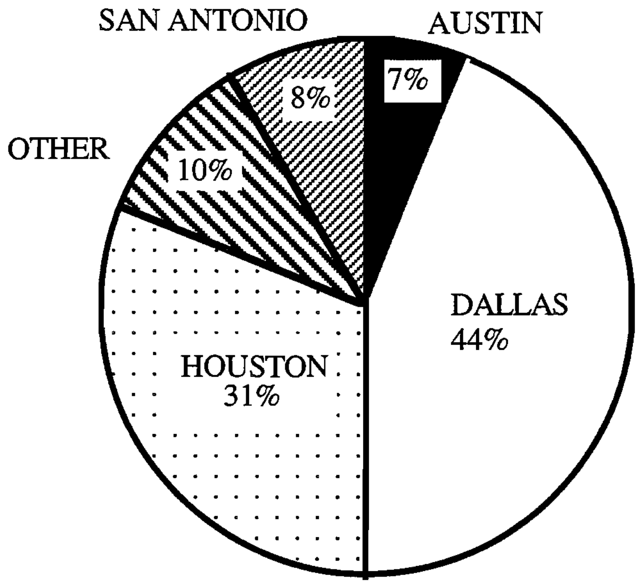

Figure 4.1 Demand distribution at Texas airports

Figures 4.2 and 4.3 show the growth in domestic and international air traffic demand, respectively, in Texas. Domestic demand has been steadily growing at an average yearly rate of 3.4 percent. International demand grew at an average of almost 8 percent between 1991 and 1993, but decreased in 1994. In 1995, the demand is expected to supersede the 1993 levels, though 1995 data consist of projections made before the Mexican peso devaluation.

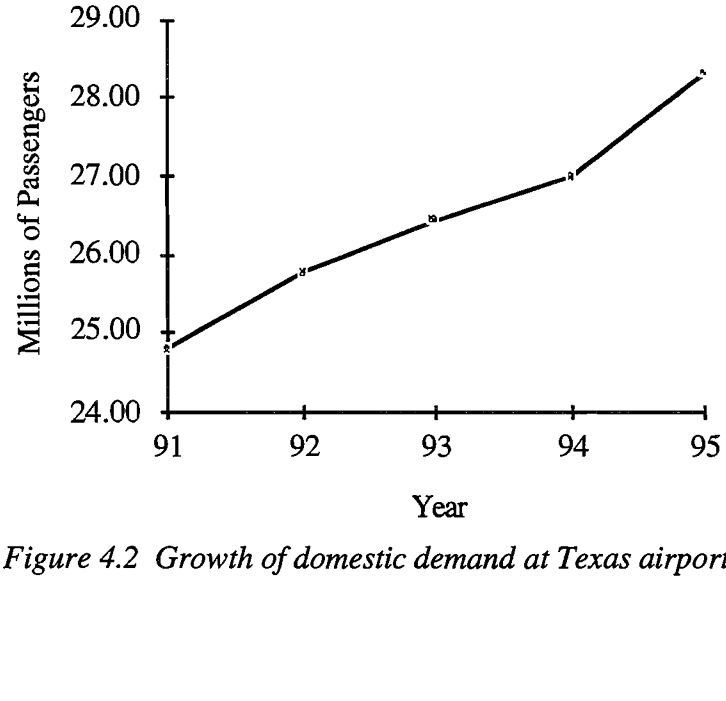

Figure 4.2 Growth of domestic demand at Texas airports

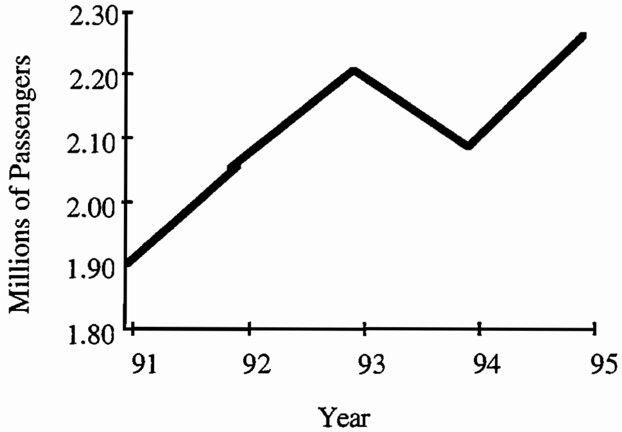

Figure 4.3 Growth of international demand at Texas airports

Table 4.4 depicts the major air traffic origins and destinations (O&D) in Texas, respectively for domestic and international flights. "Major" means any O&D pair with more than 300 passengers (or one large airplane) a day. The largest demand is that between Dallas and Houston, and the second largest is that between Dallas and San Antonio.

Table 4.4 1993 major air traffic O&Ds in Texas (1000 yearly passengers)

City	Dallas	Houston	Austin	San Antonio
Dallas	—	579	213	251
Houston	579	—	419	395
Tulsa	145	141	18	0
Chicago	311	176	49	78
New Orleans	148	230	31	50
New York	246	119	33	33
Mexico City	66	134	—	76
Atlanta	245	41	29	38

As indicated previously, the 1995 data consist of projections made before the peso devaluation, which is expected to affect Texas transportation demand. Air transport is the preferred mode for business trips, as well as for U.S.-Mexico tourism other than that between border cities. The peso devaluation may encourage U.S. tourism in Mexico, but it may negatively affect business between the two countries, including Mexican tourism in the U.S. An analysis of such effects is recommended for transportation planning purposes.

It is worthwhile to observe that the air transport data obtained by Project 2932 can also be useful for TxDOT transportation planning activities other than those at the Texas-Mexico border. It is recommended that this information be disseminated to all appropriate TxDOT departments.

Texas air transport data, while comprehensive, include only major airports. As such, the data presented in this report consistently show fewer passengers than the data routinely released by the Federal Aviation Administration (FAA). However, this difference is not entirely due to the fact that FAA's data include small airports. FAA reports the number of emplanements and deplanements at each airport, whereas the data obtained in this project report origins and destinations, rather than emplanements and deplanements; the information is therefore better suited for transportation planning purposes than FAA's data.

AIR TRANSPORT IN MEXICO

Mexican air transport data were obtained from two federal agencies, one that oversees airports and another that oversees Mexican Customs. The agency Aeropuertos y Servicios Auxiliares (ASA) is responsible for the administration of most of the airports in Mexico and periodically publishes statistics about the Mexican airport network. The 1994 issue, containing information up to 1993, is the most recent (Ref 4.5), though the information was obtained in electronic format.

Another interesting bit of information obtained in this project by Cal y Mayor Asociados refers to detailed air commerce data that supplements ASA's data base. The source is the Secretaría de Comércio y Fomento Industrial (Secretariat of Commerce and Industrial Development, or SECOFI), which releases data compiled by the Dirección General de Aduanas of the Secretaría de Hacienda y Crédito Público (Mexican Customs).These data are discussed below.

Data Description

The Mexican air traffic data are organized into three main files, one for ASA and two for SECOFI. The ASA data base contains nationwide air traffic data relating to airport operations, administration, and maintenance. The information covers 58 airports nationwide (Mexican Airport Network) for the years 1992 and 1993. With data provided for both commercial and passenger air traffic data, the data base describes the airports in detail, giving information about type of service, number of runways, type of pavement, and support facilities. This data base is in spreadsheet format, with its file structure shown in Table 4.5.

The SECOFI data base contains detailed information about international commercial air traffic, including origin and destination by commodity type, value, and weight transported. This information, stored in a spreadsheet-compatible format, was obtained by processing the most recent (1992) data base compiled by SECOFI.

The data are organized in two data base files: EXP-AER.DBF and IMP-AER.DBF, respectively, for exports and imports. The two files have analogous data structures, which are depicted in Table 4.6. Three data fields are stored as numeric codes: commodity type, state of export origin (or import destination), and Custom-house that cleared the merchandise. The codes for commodity type, Mexican states, and Custom-house (port of entry) are stored in three supporting files called HS2.DBF, ESTADOS.DBF and ADUANAS.DBF, respectively. Their structure is straightforward and self-explanatory: two fields, the first with the code, and the second with the code definition. Table 4.7 shows examples of commodity type, Mexican states, and Custom-house codes.

Table 4.5 Structure of the Mexican air traffic data (source ASA)

Column	Contents
Name	Name of the airport
Location	City, state where the airport is located
Code	Airport IATA code
Longitude	Geographical longitude, location of the airport
Latitude	Geographical latitude, location of the airport
Category	This is referring to the category of airport, i.e., domestic or international
Classification	This refers to the classification in the Mexican airport system: Metropolitano (metropolitan) Regional (regional) Turístico (tourism) Fronterizo (border)
PD92	Number of domestic passengers, during 1992
PD93	Number of domestic passengers, during 1993
PI92	Number of international passengers, during 1992
PI93	Number of international passengers, during 1993
CD92	Number of domestic tons that were transported during 1992
CD93	Number of domestic tons that were transported during 1993
CI92	International cargo handled in tons during 1992
CI93	International cargo handled in tons during 1993
OPI92	Number of international operations occurred during 1992
OPI93	Number of international operations occurred during 1993
OPT92	Total number of operations occurred during 1992
OPT93	Total number of operations occurred during 1993
Num_rwy	Number of runways
Dimension_rwy	Runways dimensions (length by width in meters)
ID_rwy	Runways identification (landing azimuth in 10°)
PVT	Type of pavement used in the runways (asphalt or concrete)
Pos_com	Number of positions designated for commercial aviation
Pos_gral	Number of positions designated for general aviation
Area	Total area of the airport in hectares (1ha=10,000 square meters)
WHS_area	Total area available to store cargo, in square meters (warehousing area)
Customs	Indicates existence of Customs activities
Hours	Operating hours of the airport

Note: All tons are metric.

Table 4.6 Structure of Mexican air commerce data

Data Field	**Contents**
HS2	Two-digit commodity classification (see file HS2.DBF)
TRANSPOR	Transportation mode code. In this case it corresponds to airborne (code 4).
PAIS	Code for country or group of countries code (origin in case of imports, destination in case of exports) 1 = United States 3 = S. & Ct. America 5 = Asia 7 = Oceania 2 = Canada 4 = Africa 6 = Europe 8 = Undisclosed
ESTADO	Mexican state code (origin of exports or destination of imports). See file ESTADOS.DBF.
ADUANA	Custom-house code of entry or exit of commodities. See file ADUANAS.DBF
DOLARES	Commodity value in US dollars
PESOS	Commodity value in Mexican pesos
PESO	Commodity weight in kilograms
SEGURO	Insurance value of commodity in Mexican pesos
IMPUESTO	Tax value of commodity in Mexican pesos

Table 4.7 Samples of the three air data code files

File	**First Column (Code)**	**Second Column (Definition)**
HS2.DBF	**07**133301	FRIJOL BLANCO (white beans)
	07133302	FRIJOL NEGRO (black beans)
ESTADOS.DBF	05	COAHUILA
	08	CHIHUAHUA
ADUANAS.DBF	07	CD. JUAREZ. CHIH
	24	NUEVO LAREDO, TAMPS.

Note: Commodities were grouped into two-digit classifications only (boldface in table).

The commodity codes warrant additional explanation. The first two digits correspond to the general commodity category, and the subsequent digits to subcategories. For example, two initial digits 09 correspond to coffee; the three subsequent digits 111, 112, and 121 correspond, respectively, to raw, decaffeinated, and roasted coffee beans; the final two digits are subcategories of coffee products as follows:

09011101 Raw coffee beans with skin
09011102 Raw coffee beans without skin
09011201 Decaffeinated coffee beans
09012101 Roasted coffee beans in hermetically closed containers
09012102 Roasted coffee (whole beans or ground), except code 09012101
09012199 All other processed coffee products

In this report, the commodities were grouped by their first two digits. Using the example above, all commodities with codes starting with "09" were grouped into general category "coffee." Analogous grouping was performed for the entire commodity code file (HS2.DBF), which originally contained 817 different commodity groups and subgroups.

The ASA data are reported by airport management and federal agencies that oversee airports; accordingly, all variables in the data base are public information and have actual values. The SECOFI data base is based on Customs declarations; consequently, it is subject to confidentiality regulations. The availability of actual information depends on the variable; some are almost entirely disclosed, while others have a high percentage of undisclosed information.

Data Discussion

The Mexican airport network contains 58 airports and a total of 77 runways. The airports are classified into border, metropolitan, regional, and tourism. They are then sub-classified into type of service (international or domestic), depending on whether they are equipped to operate international flights. All metropolitan and border airports provide international service. Table 4.8 summarizes Mexican traffic data by airport category and type of service.

Table 4.8 Summary of Mexican airport operations in 1992

Type of Service		**Year**	**Airport Category**					
			Border	*Regional*		*Tourism*		*Metropolitan*
				(INT)	(DOM)	(INT)	(DOM)	
Passengers	Domestic	1992	2,758,158	4,338,364	1,135,086	6,473,519	55,169	15,772,877
		1993	3,809,289	4,522,795	1,129,631	5,531,657	59,853	16,454,022
	International	1992	16,310	310,484	**5,444**	4,455,076	**766**	5,172,875
		1993	21,740	339,353	**16,625**	3,432,897	**0**	6,777,358
Cargo	Domestic	1992	12,524	25,480	4,983	34,779	38	85,319
		1993	14,087	29,467	6,036	38,953	44	89,691
	International	1992	23	736	**15**	10,619	0	88,770
		1993	15	686	**1**	11,004	0	103,745
Operations	Domestic	1992	104,103	300,521	110,920	247,841	3,389	380,003
		1993	102,824	318,988	115,656	282,436	3,801	451,872
	International	1992	928	7,012	**269**	54,916	**59**	66,332
		1993	2,763	8,523	**22**	48,223	**0**	92,379

There are some data discrepancies in the ASA data base. The boldface values in Table 4.8 are non-zero numbers of international trips or operations that took place in airports classified as domestic only. In some exceptional cases, a domestic airport may serve some international flights; no specific explanation was found for these numbers. Nevertheless, they are very small and have little effect on the general conclusions drawn from the data. Inconsistencies between international trips and airport type of service account for less than 0.06 percent of the total international passengers, less than 0.02 percent of the total international cargo, and less than 0.25 percent of the total international operations, both in 1992 and 1993.

According to the ASA data, there were over 30.5 million domestic emplanements and deplanements in 1992 and 31.5 million in 1993, corresponding to a 3.2 percent growth. International passenger demand increased from a little under 10 million in 1992 to over 10.5 million in 1993, a 6.3 percent growth. Domestic air cargo increased from 163,123 tons in 1992 to 178,278 tons in 1993, a 9.3 percent increase. International air cargo had the largest growth, increasing 15.3 percent between 1992 and 1993 (from 100,163 tons to 115,451 tons).

In terms of total operations (take-off and landing, both commercial and passenger airplanes), in 1992 there were, respectively, 129,516 international operations out of a 1,276,293 total. International operations increased 17.3 percent in 1993, reaching 151,910, while total operations increased 11.9 percent, totaling 1,427,487 in 1993. The portion of this air traffic that relates to international commerce can be examined in detail using the SECOFI data base.

Foreign commerce by air serves about 3 times more imports than exports. In 1992, air imports totaled nearly $4.9 billion, while exports totaled $1.48 billion. Mexico City is the major origin and destination of this foreign commerce by air. In 1992, over $805 million, or 54.4 percent of all exports value, and $3.2 billion, or almost 66 percent of the imports value, flew either in or out of Mexico City.

For exports, the state of Jalisco ranks second, with $243 million (16.4 percent) in exports. Mexico state ranks third, with nearly $114 million (7.7 percent). For imports, the state of Mexico ranks second, serving over $694 million (or 14.2 percent) in imports. The state of Jalisco is third, importing $237.5 million, or nearly 5 percent of the total imports by air.

Tables 4.9 and 4.10, respectively, show summaries of exports and imports origins and destinations. Each table cell has two rows: The top row shows 1992 dollars, and the bottom row shows the percentage of the total (import or export value).

Commerce with the U.S. accounts for $784 million in exports and nearly $2 billion in imports. This corresponds, respectively, to nearly 53 percent of Mexican exports and 41 percent of its imports. Europe ranks second, contributing nearly 22 percent of the exports' value, or $320 million. In terms of imports, Europe is the primary consumer of air transport. Mexico imported $2.3 billion from Europe, or over 47 percent of the value of the goods imported by air.

Exports that have their origin in Mexico City and their destination in the U.S. account for over $441 million, or nearly 30 percent of all value exported by air in 1992. The second largest origin and destination pair reflects Mexican exports to the U.S. originating anywhere but Mexico City, Mexico State, and Jalisco: It totals over $441 million and corresponds to nearly 14 percent of the total. Finally, exports to the U.S. originating in Jalisco occupy the third position, totaling $108 million and over 7 percent of the total value.

Table 4.9 Origin and destination of Mexican exports by air (1992 dollars)

Export Origin	Export Destination							Total Origin
	US	Canada	Ct. & S. America	Africa	Asia	Europe	Oceania	
Mexico City	4.416E8 29.8%	2.148E7 1.5%	1.314E8 8.9%	286763 0.02%	4.52E7 3.05%	1.6E8 10.8%	5886918 0.40%	8.059E8 54.4%
Jalisco	1.083E8 7.31%	3351298 0.23%	3.137E7 2.12%	12508 0.00%	4.89E7 3.30%	5.166E7 3.48%	173,445 0.01%	2.438E8 16.4%
Mexico State	3.064E7 2.07%	3083244 0.21%	4.424E7 2.98%	163,261 0.01%	1.418E6 0.10%	3.344E7 2.26%	820,475 0.06%	1.138E8 7.7%
All Others	2.037E8 13.74%	4.58E6 0.31%	1.769E7 1.19%	43,657 0.00%	1.455E7 0.98%	7.435E7 5.01%	4.328E6 0.29%	3.192E8 21.5%
Total Destin.	7.842E8 52.89%	3.25E7 2.19%	2.247E8 15.16%	506,189 0.03%	1.101E8 7.42%	3.195E8 21.55%	1.121E7 0.76%	1.483E9 100%

Note: 2.148E7=2.148 x 10^7 = 21,480,000.

Table 4.10 Origin and destination of Mexican imports by air transport (1992 dollars)

Import Origin	Import Destination			Total Origin
	All Other	Mexico City	Mexico State	
U.S.	4.622E8 9.46%	1.424E9 29.13%	1.12E8 2.29%	1.998E9 40.87%
Canada	6155128 0.13%	3.857E7 0.79%	4203760 0.09%	4.893E7 1.00%
Ct. & South America	2.976E7 0.61%	9.503E7 1.94%	1.176E7 0.24%	1.366E8 2.79%
Africa	1207518 0.02%	1770782 0.04%	286423 0.01%	3264723 0.07%
Asia	9.43E7 1.93%	2.44E8 4.99%	4.356E7 0.89%	3.819E8 7.81%
Europe	3.978E8 8.14%	1.387E9 28.38%	5.219E8 10.68%	2.307E9 47.20%
Oceania	448478 0.01%	1.144E7 0.23%	625650 0.01%	1.251E7 0.26%
N/A	19566 0.00%	0 0.00%	0 0.00%	19566 0.00%
Total Destination	9.92E8 20.30%	3.201E9 65.50%	6.943E8 14.21%	4.888E9 100.00%

Imports that have their destination in Mexico City and their origin in the U.S. account for over $1.4 billion, or nearly 30 percent of all value imported by air in 1992. The second largest origin and destination pair, which ranks closely with the largest, reflects Mexican imports from Europe with a destination in Mexico City. This category totals over $1.38 billion and corresponds to a little over 28 percent of the total. Finally, imports from Europe with a destination in Mexico State occupy the third position, totaling $521 million and over 10 percent of the total value. This is close to the total amount imported from the U.S. that has destinations other than Mexico City or Mexico State ($462 million, or 9.6 percent).

Data on origins and destinations of airborne commerce are quite complete; less than 0.1 percent of the data are undisclosed, and the findings discussed above truly represent the entire data base. Commodity types, on the other hand, have a considerable amount of undisclosed information. Over 70 percent of the total value of imports and nearly 81 percent of the total value of exports correspond to undisclosed commodities. Nevertheless, the SECOFI data provide some interesting insights into the nature of the airborne commerce.

Organic chemicals such as ethylene, propane, naphthalene, benzene, and others correspond to more than 5 percent of the export value, or almost 27 percent of the value of known commodities exported by Mexico by air. Precious metals such as gold and silver make up another 6 percent of total exports, or 31 percent of the known commodities. Medical products derived from human plasma correspond to 15.7 percent of the disclosed export's value and to 3 percent of the total value. Maquiladora products, which are a special category in airborne commodity classification, appear only as 0.1 percent of the value of exports of known commodities. This figure may indicate a predominance of land transport use by maquiladora exports (NAFTA land commerce is discussed in detail in the next report of this series, Report 2932-2).

Tables 4.11 and 4.12 summarize commodity types exported by Mexico, respectively, by country of destination and state of origin. The conclusions are general inasmuch as commodity types are undisclosed for nearly 81 percent of exports. All disclosed commodities other than organic chemicals and precious metals account for only 8 percent of the total exported value.

Tables 4.13 and 4.14 summarize commodity types imported by Mexico, respectively, by country of origin and state of destination. Seventy one percent of the imported value has undisclosed commodities. Based on the disclosed commodities, the maquiladora industry is the most important consumer of air transport, totaling $572 million or 11.7 percent of all imported value by air, and over 40 percent of all imports having known commodities. Organic chemicals such as ethylene, propane, naphthalene, benzene, and others correspond to 7.7 percent of the import value, or almost 26.5 percent of the known commodities imported by Mexico by air. Precious metals such as gold and silver make up another 3.4 percent of total imports, or 11.6 percent of the known commodities. Medical products derived from human plasma correspond to 7.8 percent of the disclosed imports and 2.3 percent of the total.

Table 4.11 Destination of commodities exported by Mexico by air (1992 dollars)

Country of Destination	Commodity Type				Total Destination
	Organic Chemicals	Precious Metals	Un-disclosed	Other (less than 5%)	
U.S.	1.511E7 1.02%	4.874E7 3.29%	6.658E8 44.90%	5.456E7 3.68%	7.842E8 52.89%
Canada	915448 0.06%	647691 0.04%	2.831E7 1.91%	2620676 0.18%	3.25E7 2.19%
S. and Ct. America	2.541E7 1.71	1358725 0.09	1.592E8 10.74	3.874E7 2.61%	2.247E8 15.16%
Africa	53667 <0.01%	947 <0.01%	341188 0.02%	110387 0.01%	506189 0.03%
Asia	5876740 0.40%	1936389 0.13	9.538E7 6.43	6876837 0.46	1.101E8 7.42%
Europe	2.435E7 1.64%	3.564E7 2.40%	2.435E8 16.42%	1.605E7 1.08%	3.195E8 21.55%
Oceania	3979480 0.27%	24228 <0.01%	6779785 0.46%	425161 0.03%	1.121E7 0.76%
Total Commodity	7.569E7 5.11%	8.835E7 5.96%	1.199E9 80.88%	1.194E8 8.05%	1.483E9 100%

Table 4.12 Origin of commodities exported by Mexico by air (1992 dollars)

Export Origin	Commodity Types				Total Origins
	Organic Chemicals	Precious Metals	Undisclosed	Other (less than 5%)	
Mexico City	2.175E7 1.47%	6.19E7 4.17%	6.51E8 43.90%	7.131E7 4.81%	8.059E8 54.35%
Jalisco	56873 <0.01%	4431878 0.30%	2.34E8 15.78%	5262748 0.35%	2.438E8 16.44%
Mexico State	2.525E7 1.70%	967140 0.07%	7.474E7 5.04%	1.284E7 0.87%	1.138E8 7.68%
Other	2.864E7 1.70%	2.105E7 0.07%	2.395E8 5.04%	2.996E7 0.87%	3.192E8 7.68%
Total Comm.	7.569E7 5.11%	8.835E7 5.96%	1.199E9 80.88%	1.194E8 8.05%	1.483E9 100%

Table 4.13 Origin of commodities imported by Mexico by air (1992 dollars)

Import Origin	**Commodity Types**				**Total Origin**
	Organic Chemicals	Maquiladora Input	Undisclosed	Other (less than 5%)	
US	3.448E7 0.71%	2.451E8 5.01%	1.515E9 31.00%	2.032E8 4.16%	1.998E9 40.87%
Canada	525172 0.01%	3564592 0.07%	3.975E7 0.81%	5086476 0.10%	4.893E7 1.00%
Other America	2.322E7 0.48%	8603872 0.18%	8.338E7 1.71%	2.136E7 0.44%	1.366E8 2.79%
Africa	107775 <0.01%	28160 <0.01%	922411 0.02%	2206377 0.05%	3264723 0.07%
Asia	1.262E7 0.26%	3.89E7 0.80%	3.097E8 6.34%	2.065E7 0.42%	3.819E8 7.81%
Europe	3.035E8 6.21%	2.754E8 5.63%	1.516E9 31.01%	2.122E8 4.34%	2.307E9 47.20%
Oceania	528987 0.01%	170026 <0.01%	2378345 0.05%	9435388 0.19%	1.251E7 0.26%
Undisclosed	0 0.00	0 0.00	19566 <0.01%	0 0.00	19566 0.00%
Total Commodity	3.75E8 7.67%	5.717E8 11.70%	3.467E9 70.93%	4.741E8 9.70%	4.888E9 100%

Table 4.14 Destination of commodities imported by Mexico by air (1992 dollars)

Import Destination	**Commodity Types**				**Total Destination**
	Organic Chemicals	Maquiladora Input	Undisclosed	Other (less than 5%)	
Mexico State	2.491E7 0.51%	1.217E8 2.49%	5.107E8 10.45%	3.705E7 0.76%	6.943E8 14.21%
Mexico City	3.272E8 6.70%	2.444E8 5.00%	2.283E9 46.71%	3.466E8 7.09%	3.201E9 65.50%
All Others	2.282E7 0.47%	2.057E8 4.21%	6.731E8 13.77%	9.037E7 1.85%	9.92E8 20.30%
Total Commodity	3.75E8 7.67%	5.717E8 11.70%	3.467E9 70.93%	4.741E8 9.70%	4.888E9 100%

The shares and geographical distribution of commodities listed above are minimum values for each disclosed commodity. The undisclosed commodities are the most significant category, and as such they may encompass additional shipments of the known categories discussed in this section and depicted in Tables 4.11 through 4.14.

The most recent international commerce data file was for 1992, before NAFTA. Because NAFTA may have changed the origin and destination profile of airborne international commerce, a follow-up study of post-NAFTA air commerce patterns could better assist statewide air transportation planning.

RAIL TRANSPORTATION

U.S. transborder rail data are available from the USDOT in terms of commodity values (not in terms of tonnage or rail cars). These data contain detailed origin and destination information, and are thoroughly discussed in the second report of this series (Report 2932-2).

Mexican rail data were obtained by our subcontractor, Cal y Mayor Asociados, from Ferrocarriles Nacionales de Mexico (FERRONALES, or FNM), which operates and manages all railways in Mexico. The data consist of:

(1) a set of maps containing rail transportation summaries for 1991, 1992, and 1993, which include nationwide origin and destination of Mexican trains;

(2) a 10-year historical series of rail operations statistics in Mexico, from 1984 to 1994; and

(3) Mexican foreign commerce transported by rail in 1992, 1993, and 1994.

The historical series include equipment, railroad length and maintenance, fleet data, labor data, passenger demand, cargo demand by commodity type, and fuel consumption (Ref 4.20). The foreign commerce data are the most relevant for TxDOT transportation planning purposes. They contain origin of Mexican exports, destinations of imports, station of entry/exit along the U.S.-Mexico border, commodity type, number of rail cars, and ton-km of foreign commerce moved by rail. The data are restricted to the Mexican territory, that is, they do not include information outside Mexico. Therefore, final destination of exports and initial origin of imports are not reported. On the other hand, FNM, a federal agency, was the only entity operating rail in Mexico up to 1994. By contrast with the U.S. side, where railroads are private, there is no proprietary information involved. All data are public domain, and the information on stations of entry/exit of imports/exports provides a good picture of Texas' role as a major gateway for NAFTA commerce moving by rail transportation, and supplements information on value of shipments (discussed in the second report of this series).

Description of the Rail Maps

The Mexican rail maps obtained by this project can be classified into three types: Type 1 and 2 maps are available for years 1991, 1992, and 1993; Type 3 maps are available for 1992 and 1993. Copies of these maps could not be included in this report because of their size (they are not readable when reduced). Type 1 maps are available for 1991, 1992, and 1993. They include the following information:

(1) average monthly number of trains (freight, passenger, and mixed use) in each rail link;

(2) a summary graph showing the average daily number of trains observed each month of the year, disaggregated by freight, passenger, and mixed use; monthly number of trains (freight, passenger, and mixed use) in each rail link; and

(3) history of total annual number of trains during the four years before the map date, disaggregated by freight, passenger, and mixed use.

Type 2 maps are available for 1991, 1992, and 1993. They include additional freight information as follows:

(1) average monthly tons (gross and net) moved between each origin and destination pair;

(2) a summary table showing a four-year history of ton-km of freight, disaggregated by gross and net tons, and by type of train (freight or mixed use).

Type 3 maps are available for 1992 and 1993. They disaggregate the information by loaded and empty rail cars. They include the following information:

(1) average daily number of rail cars (loaded and empty) between each origin and destination pair;

(2) a summary graph showing the average daily number of rail cars for each month, disaggregated by ownership (FNM, private, and other rail companies);

(3) a summary table showing a five-year history of average daily number of rail cars, disaggregated between the following types of owners: FNM, private domestic, private foreign, U.S. and Canada.

All maps include an outline of all Mexican rail lines and routes. Consequently, all the information they contain is organized by origin and destination pair. This information includes trains carrying exports and imports, but is restricted to the Mexican territory; at best, the data report the last Mexican station used before crossing the border. It is important to note that, for each station, there is no distinction between export/import trains and those with actual origin or destination at a border station.

Foreign Commerce Data Description

The Mexican import and export data are available for the years 1992, 1993, and 1994. The files are in DBASE format, which is compatible with spreadsheets. The data are disaggregated in two ways: by pairs of origin and destination (O&D), and by port of entry (field "ADUANA"). All files contain the following information: number of rail cars, commodity, weight, and ton-km. Table 4.15 summarizes the import-export rail data files.

Table 4.15 Summary of data on Mexican foreign trade by rail

Year	Direction	Data Disaggregation	
		O&D	Port of Entry
1992	Imports Exports	I92_E6.DBF X92_E6.DBF	IAC92C.DBF XAC92C.DBF
1993	Imports Exports	n/a n/a	IAC93C.DBF XAC93C.DBF
1994	Imports Exports	I94_E6.DBF X94_E6.DBF	n/a n/a

The data structure and levels of disaggregation change from year to year. For 1992, all files are disaggregated by month, while 1993 and 1994 are available in terms of yearly totals. Table 4.16 shows the structure of the 1992 data files disaggregated by port of entry, while Table 4.17 shows the organization of 1992 origin and destination files.

Table 4.16 Structure of files disaggregated by port of entry

Variable	Definition
ADUANA	Port of Entry
COMM	Commodity
CARS	Number of rail cars
TON	Weight in tons
TON_KM	Tons-kilometer
CARS2	Number of rail cars accumulated up to the related month
TON2	Weight in tons accumulated up to the related month
MON	Abbreviation of the related month

Table 4.17 Structure of files disaggregated by O&D

Variable	Definition
NOM_REM	Shipper railway station
NOM_REC	Receiver railway station
COMM	Commodity
DIST	Distance between origin and destination railway stations
CARS	Number of railcars
TON	Weight in tons
TON_KM	Ton-kilometers
MON	Abbreviation of the related month

For 1993, imports and exports data by port of entry are available only for the month of December and aggregated for the entire year. Data by origin and destination pairs were not available for this year. The structure of the 1993 files is similar to that depicted in Table 4.16, except that the variable MON (month) is not present. For 1994, yearly data are available by origin and destination pairs, but not by port of entry. The data base structure is similar to that of 1992 (Table 4.17), except that all data refer to the whole year, and month is not available.

The scope of Mexican rail data is domestic; therefore, O&D pairs correspond to receiver and shipper stations inside Mexico. For imports, the data have two location records: The first record is the border station where the commodity first entered Mexico (shipper), and the second record is the station of destination (receiver). For exports, the first record is the border station through which the commodity left Mexico (receiver); the second record is the station where the commodity was initially shipped (shipper). Consequently, the data provide no information about Mexican imports origin and exports destination; however, the "shipper" station for imports and "receiver" station for exports give valuable information about the share of each border crossing in serving NAFTA commerce originating or terminating in Mexico.

Data Discussion

FNM data indicate a considerable decline in the use of rail transportation in Mexico, both for cargo and for passengers. Available railroads increased only 15 percent between 1940 and 1994, as shown in Figure 4.4. This corresponds to an average yearly growth rate of only 0.2 percent. Demand for passengers and cargo, however, decreased continuously and did not even keep up with the very modest growth in railroads, as shown in Figure 4.5. Cargo tonnage decreased from 64 million tons in 1984 to 52 million tons in 1994. Cargo ton-km decreased from 44.59 billion to 37.31 billion over the 1984–1994 period. Passenger demand dropped from 5.9 billion passenger-km of travel (PKT) in 1984 to 1.86 billion in 1994.

The demand drop seems to have encouraged productivity. As the demand decreased, so did the number of jobs in the rail sector, as shown in Figure 4.6. In 1986, there were 80,000 rail employees, dropping to about 50,000 in 1994. During the same period, the productivity increased from 0.57 million ton-km plus PKT per job to nearly 0.8 million. This increase in productivity occurred despite a simultaneous decrease in number of locomotives. As shown in Figure 4.7, the number of locomotives decreased from 1,878 in 1984 to 1,426 in 1994, a 24 percent decrease. The overall potency decreased less than the number of locomotives, indicating some fleet modernization. Total potency decreased about 11 percent (from nearly 3,500MW in 1984 to less than 3,100MW in 1994).

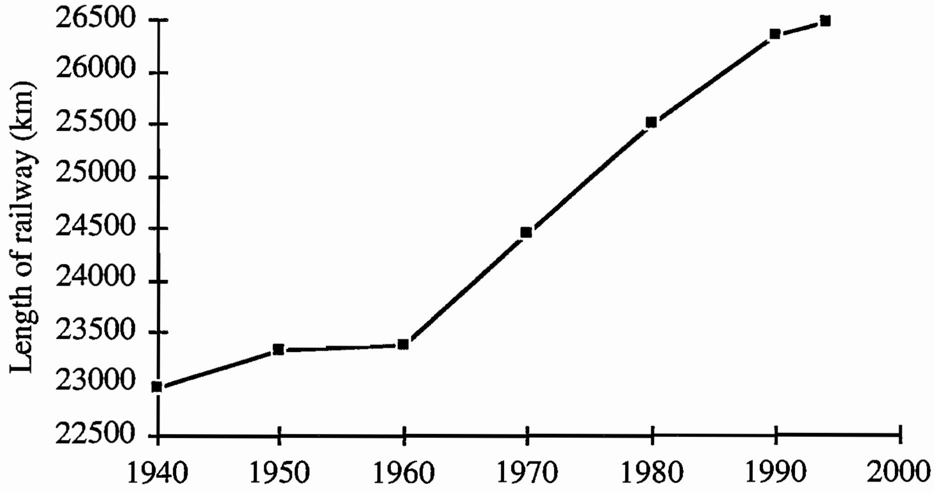

Figure 4.4 Evolution of railroads in Mexico

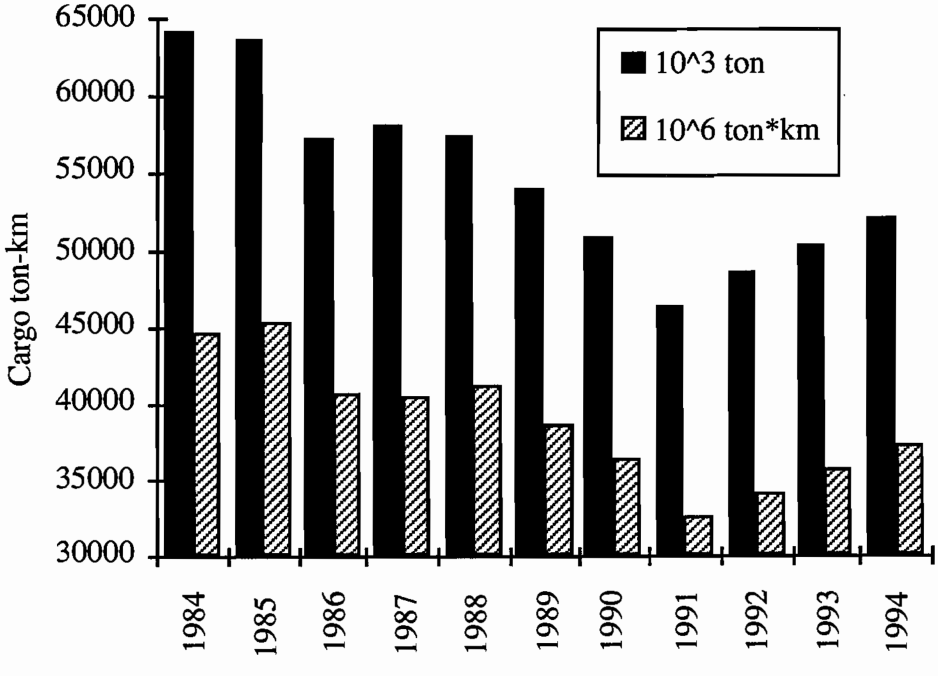

Figure 4.5 Evolution of rail cargo demand in Mexico

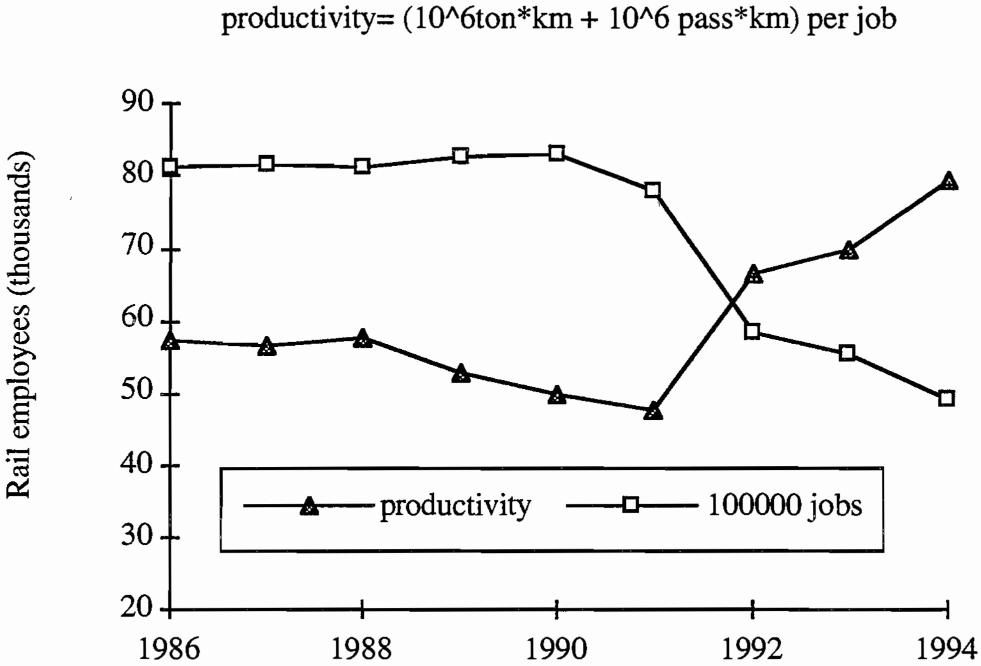

Figure 4.6 Evolution of rail employment productivity in Mexico

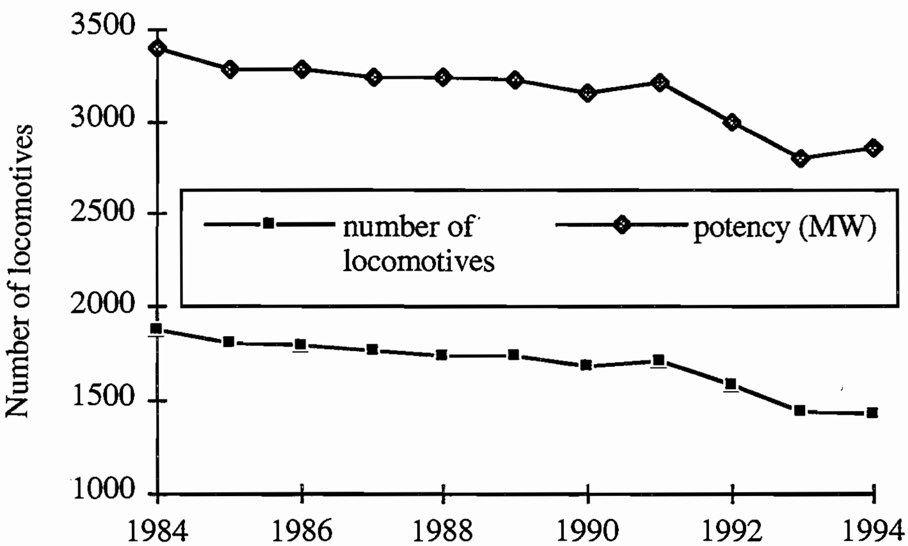

Figure 4.7 Evolution of rail equipment in Mexico

This steady decrease in rail demand did not occur for international commerce. Between 1992 and 1994, the number of rail cars exporting goods from Mexico increased from 85,362 to 118,821, while tonnage increased almost 14 percent, from 3.8 to 5.3 million. For imports, the number of rail cars increased from 211,476 in 1992 to 238,519 in 1994. Tonnage increased over 20 percent, from 13.4 to 16.1 million tons between 1992 and 1994. Ton-km more than doubled, from 23.8 billion in 1992 to over 60 billion in 1994, perhaps indicating an increase in commerce with distant parts of North America following NAFTA implementation. Figures 4.8 and 4.9 summarize increases in Mexican foreign commerce by rail, respectively, for rail cars and tonnage of cargo.

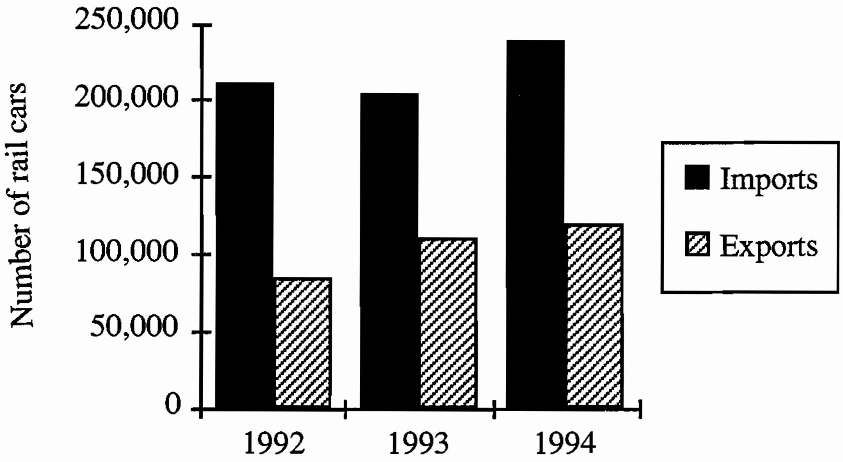

Figure 4.8 Growth of Mexican foreign trade by rail — rail cars

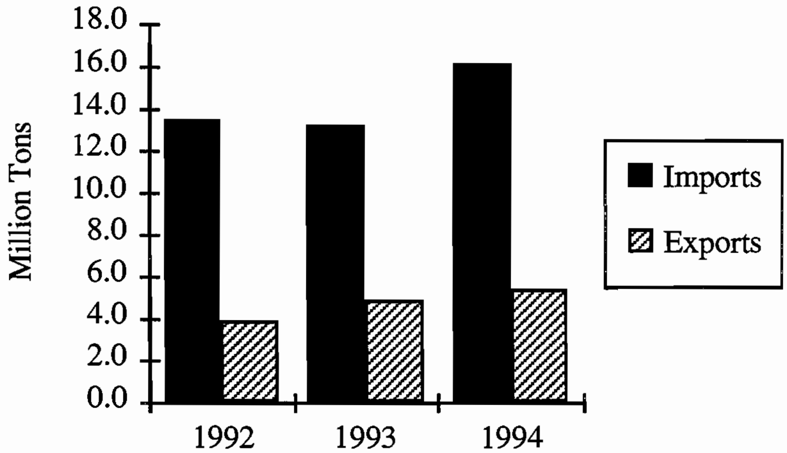

Figure 4.9 Growth of Mexican foreign trade by rail — tonnage

Texas' role in transporting Mexican international rail commerce can be discussed based on an analysis of ports of entry used by these imports/exports. Table 4.18 shows the number of rail cars and the tonnage of exports by rail in 1994, along the entire U.S.-Mexico border. Table 4.19 shows analogous data for Mexican imports.

Receiver and shipper stations located on the Texas-Mexico border are printed in boldface in Tables 4.18 and 4.19. Stations printed in italics are those located away from the border, but with a Texas station as the most convenient way to reach the U.S., based on an examination of Mexican rail lines and rail maps (Ref 4.4). Some stations have more than one convenient route to the border — that is, one might pass through Texas and another might pass through other states. These are marked with an asterisk (*). Stations located either at other states' border with Mexico or at locations that seem unlikely to reach the U.S. through the Texas border are not highlighted in Tables 4.18 and 4.19.

Tables 4.20 and 4.21 are extracts from Tables 4.18 and 4.19 containing only the stations at the Texas-Mexico border and those requiring long detours to reach the U.S. through a state other than Texas. Figures 4.10 and 4.11 summarize Texas' role as a gateway for rail traffic between Mexico and the rest of the NAFTA territory (respectively, in terms of rail cars and freight tonnage). The predominance of Texas' role in serving Mexico's international commerce by rail is evident from the data even after disregarding additional rail traffic from some stations located on routes that lead to the Texas border (marked with * in Tables 4.18 and 4.19).

Table 4.18 Mexican exports by rail in 1994

Receiver Station	Rail Cars	Percent	Tons	Percent
Cd. Hidalgo*	5,246	4.42	143,913	2.69
Cd. Juarez	4,454	3.75	258,570	4.84
Coatzacoalco*	31	0.03	191	0.00
Guaymas, Son	14,032	11.81	1,046,830	19.59
L. Cardenas*	4,214	3.55	143,618	2.69
Manzanillo	3,460	2.91	54,529	1.02
Matamoros	2,639	2.22	181,839	3.40
Mexicali, BC	528	0.44	25,922	0.48
Nogales, Son	20,122	16.93	594,800	11.13
Nuevo Laredo	29,467	24.80	977,320	18.29
Piedras Negras	15,087	12.70	603,082	11.28
Salina Cruz	390	0.33	11,394	0.21
Tampico, TM	17,115	14.40	1,222,809	22.88
Veracruz, Ver*	2,036	1.71	79,979	1.50

The Texas border served at least 238,519 rail cars carrying over 32.4 million tons in 1994. Laredo alone served nearly 45 percent of the Mexican imports, both in terms of rail cars and tonnage. It also served almost 25 percent of all northbound rail cars, which carried over 18 percent of all northbound tonnage by rail. This traffic is expected to grow. Union Pacific has invested over $25 million in Laredo alone and is expected to invest another $75 million in additional border infrastructure over the next four years (source: 1994 interviews with Mr. R. Blackburn, UP vice-president for Mexico, and with several border inspectors).

Table 4.19 Mexican imports by rail in 1994

Shipper Station	**Rail Cars**	**Percent**	**Tons**	**Percent**
Cd. Hidalgo*	492	0.21	29,864	0.19
Cd. Juarez	20,321	8.52	1,672,332	10.38
Coatzacoalco*	4,210	1.77	311,283	1.93
Guaymas, Son	1,447	0.61	95,223	0.59
L. Cardenas*	5,523	2.32	184,784	1.15
Manzanillo	12,424	5.21	813,246	5.05
Matamoros	19,029	7.98	1,495,318	9.28
Mazatlan	13	0.01	725	0.00
Mexicali, BC	1,645	0.69	84,245	0.52
Navojoa, Son	2	0.00	135	0.00
Nogales, Son	5,854	2.45	435,770	2.70
Nuevo Laredo	106,638	44.71	7,249,196	44.99
Ojinaga	517	0.22	44,421	0.28
Piedras Negras	20,750	8.70	1,096,494	6.81
Salina Cruz	319	0.13	5,320	0.03
Tampico, TM	6,852	2.87	493,726	3.06
Veracruz, Ver*	32,483	13.62	2,100,272	13.04

Table 4.20 Mexican exports by rail in 1994 through Texas

Origin	**Rail Cars**	**Percent**	**Tons**	**Percent**
Cd. Juarez	4,454	6.4	258,570	7.9
Matamoros	2,639	3.8	181,839	5.6
Nuevo Laredo	29,467	42.6	977,320	30.0
Piedras Negras	15,087	21.8	603,082	18.5
Salina Cruz	390	0.6	11,394	0.4
Tampico, TM	17,115	24.7	1,222,809	37.6
TOTAL	69,152	100.0	3,255,014	100.0

Table 4.21 Mexican imports by rail in 1994 through Texas

Destination	Rail Cars	Percent	Tons	Percent
Cd. Juarez	20,321	11.7	1,672,332	13.9
Matamoros	19,029	10.9	1,495,318	12.4
Nuevo Laredo	106,638	61.1	7,249,196	60.1
Ojinaga	517	0.3	44,421	0.4
Piedras Negras	20,750	11.9	1,096,494	9.1
Salina Cruz	319	0.2	5,320	0.0
Tampico, TM	6,852	3.9	493,726	4.1
TOTAL	174,426	100.0	12,056,807	100.0

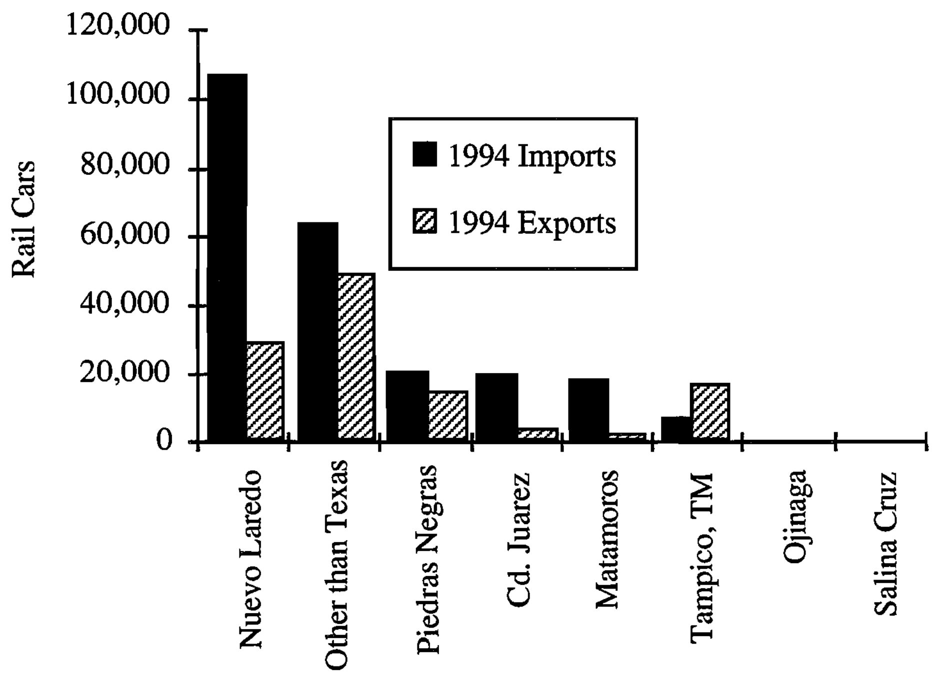

Figure 4.10 Rail cars using the Texas-Mexico border

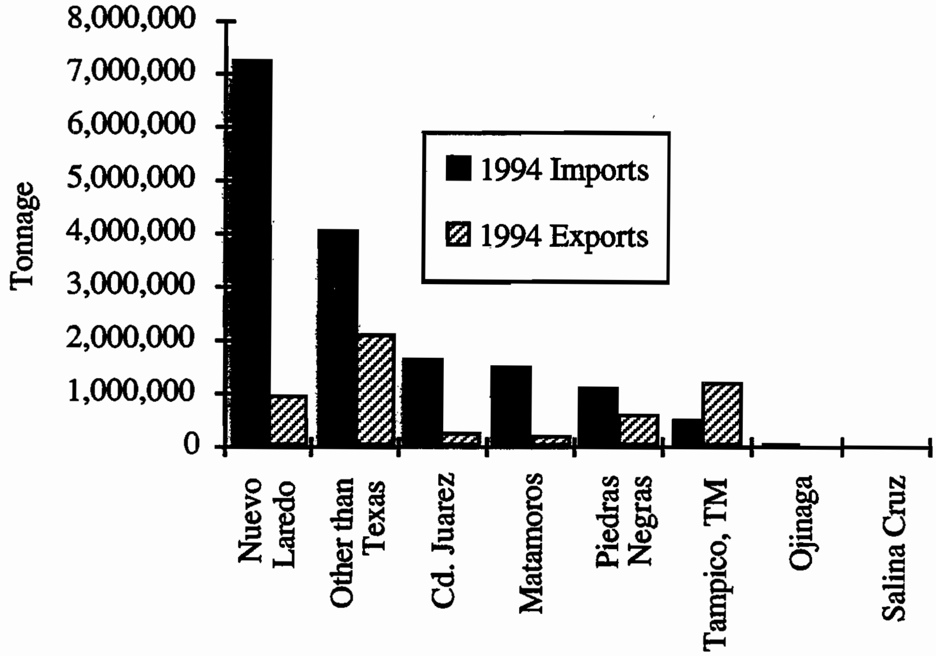

Figure 4.11 Rail freight tonnage using the Texas-Mexico border

Conclusions

Although rail facilities in Texas are all privately owned and operated, TxDOT must coordinate with the rail companies to plan improvements in the supporting infrastructure. Furthermore, an effective, environmentally friendly and energy-efficient transportation system must enhance coordination among the various modes. This is especially true for rail-highway intermodal transport at the Texas-Mexico border. While the rail companies are reluctant to disclose information that may help identify their market share, the Mexican rail data are public domain; they assert the importance of Texas as a major gateway for NAFTA commerce by rail, and should be used by TxDOT in its border planning efforts.

The operation of several FNM rail lines are now imperiled by Mexico's program of privatization and concession. Cal y Mayor Asociados (our Mexican subcontractor) informed us that this may cause gaps in the data recorded after 1995, since FNM will not keep detailed records of lines operating under concession, and, furthermore, the concessionaires may choose to invoke confidentiality rules and refuse to disclose data. For transportation planning purposes, this situation will mirror that prevailing in Texas, since on the U.S. side rail lines are private, and the amount and type of information they agree to disclose is not sufficient for multimodal transportation planning on a regional basis.

WATERBORNE TRANSPORTATION

While Texas ports play a very important role in U.S-Mexico trade, they are neither built, operated, nor maintained by TxDOT. Rather, most Texas ports fund their improvement projects by issuing revenue bonds (Ref 4.14). TxDOT must, however, provide and plan for supporting infrastructure for existing and future ports; furthermore, TxDOT must be able to estimate what share of the ports' tonnage actually serves other states. In the U.S., maritime traffic data are available from individual ports and from federal sources (Refs 4.10, 4.11).

Mexican waterborne data were obtained from Puertos Mexicanos, an agency that oversees all ports in Mexico. The data consist of:

(1) a 1984-1992 historical series of cargo and passenger movements at Mexican ports;
(2) statistics of cargo and passenger movements at the main Mexican ports, for the years 1993 and 1994; and
(3) international maritime commerce with origin and destination of all commodities, for 1991.

The international maritime commerce data are the most interesting for TxDOT, since they provide estimates of Texas port utilization by NAFTA-related commerce. Mexican port statistics, historical series, and passenger movements are relevant to binational transportation planning, since they provide information related to general capacity and movements at Mexican ports.

Data Description

The data in historical series format contain the evaluation of cargo and passenger in all major Mexican ports from 1984 to 1992 (Ref 4.8). The historical series consist of the following data:

(1) total cargo tonnage disaggregated by type (non-containerized, containerized, agricultural, minerals, and fluids), type of trip (deep sea or coastal), and port;
(2) total imported and exported tonnage disaggregated by port and by cargo type (non-containerized, containerized, agricultural, minerals, and fluids);
(3) total number of containers by port;
(4) total number of vessels at each port; and
(5) total number of passenger ships at each port.

The Mexican port data for 1992-1993 and 1993-1994 consist of tables presenting port statistics comparing 1992 to 1993 and 1993 to 1994. The data are presented in terms of comparative tables of cargo types (non-containerized, containerized, agricultural, minerals, and fluids), type of traffic (deep sea or coastal), type of movement (imports, exports, and coastal), containers, and passengers (Refs 4.6, 4.7).

The international maritime traffic data for 1991 include origins, destinations, and commodity types of all major Mexican ports in that year. The data also include intermodal information, showing the tonnage of each commodity transported to or from the Mexican port by each mode (truck, rail, and pipeline). The import and export files have similar structures, as shown in Table 4.22. Fields PTO (port), COMM (commodity), and T-CARG (cargo type) are the same, but origins and destinations differ. Import files show country and port of origin and state of destination in Mexico, while export files show state of origin in Mexico and country and port of destination.

Table 4.22 Structure of the waterborne import and export file

Field #	Import File		Export File	
	Field Name	**Meaning**	**Field name**	**Meaning**
1	PTO	Port	PTO	Port
2	COMM	Commodity	COMM	Commodity
3	T_CARG	Cargo Type	T_CARG	Cargo Type
4	ORI_PTO	Port of Origin	ORI_ST	State of Origin
5	ORI_C	Country of Origin	DES-PTO	Port of destination
6	DES_ST	State of Destination	DES_C	Country of destination
7	FC	Tenths of kilograms of the commodity being transported to its final destination by railway ("FerroCarrile")	FC	Tenths of kilograms of the commodity being transported to the port of exit by railway
8	CARR	Tenths of kilograms of the commodity being transported to its final destination by highway (**carretera**)	CARR	Tenths of kilograms of the commodity being transported to the port of exit by highway
9	DUCTO	Tenths of kilograms of the commodity being transported to its final destination by pipeline (**ducto**)	DUCTO	Tenths of kilograms of the commodity being transported to the port of exit by pipeline

Data Discussion

In 1991, Mexican foreign commerce by sea totaled 4.5 trillion tons, of which 1.42 trillion were imported and 3.18 trillion exported. Even before NAFTA, the U.S. and Canada were important trade partners, playing a dominant role in Mexico's waterborne foreign commerce. This is clear from the data in Table 4.23, which are also depicted in Figures 4.12 and 4.13. The U.S. was the origin of 49 percent of the waterborne imports and 52 percent of the exports in the analysis year (1991). This corresponds to a total of 2.34 trillion tons, 0.7 imported by Mexico and 1.65 exported by Mexico from the United States. Canada's participation was significantly less: 4 percent of imports and less than 0.15 percent of Mexican exports.

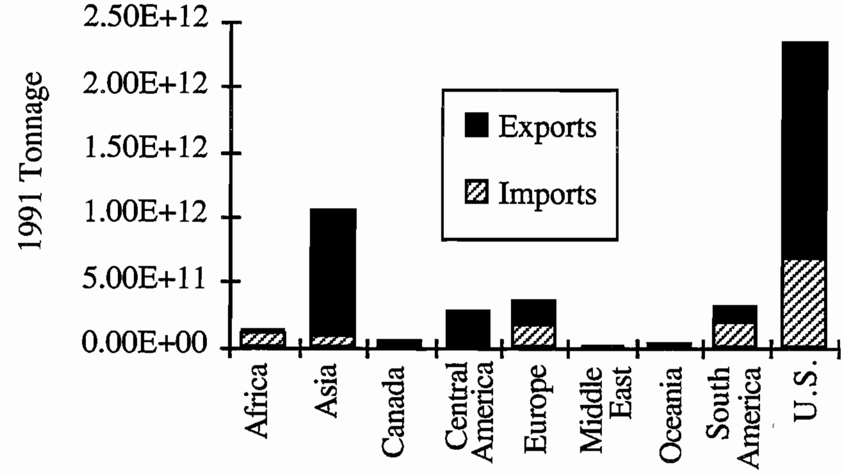

Figure 4.12 Mexican waterborne commerce by region

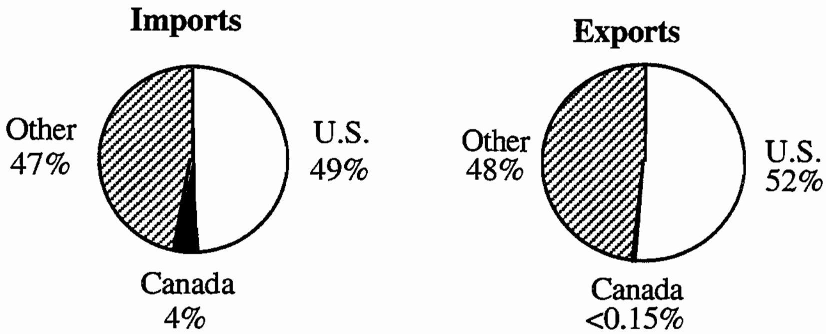

Figure 4.13 Mexico's main trade partners in waterborne commerce

Table 4.23 Mexican waterborne foreign commerce by region (1991)

Region	**Imports**		**Exports**	
	Tonnage	**Percent**	**Tonnage**	**Percent**
Africa	1.188E11	8.4	1.815E10	0.6
Asia	9.88E10	7.0	9.652E11	30.4
Canada	5.841E10	4.1	4.399E9	0.1
Central America	3.34E10	2.4	2.417E11	7.3
Europe	1.89E11	13.3	1.687E11	5.3
Middle East	2.5354E8	0.0	1.056E10	0.3
Oceania	2.753E10	1.9	6.0393E8	0.0
South America	1.981E11	13.9	1.221E11	3.9
U.S.	6.963E11	49.0	1.65E12	52.0
TOTAL	1.420E12	100	3.18E12	100

Texas ports are important in serving this waterborne commerce, as shown in Tables 4.24, 4.25, and 4.26. These tables, respectively, show Mexico's worldwide commerce, its NAFTA-related portion only (origins of imports and destinations of Mexico's exports restricted to U.S. and Canada), and the origins and destinations of Mexican imports and exports to and from the NAFTA territory. Texas served almost 15 percent of Mexico's imports by sea, and nearly 20 percent of its exports worldwide, while serving 25.5 percent of its imports and 37.7 percent of its exports to and from the U.S. and Canada.

The data also permit an analysis of Texas' role in serving other states' waterborne commerce with Mexico. Texas ports served nearly 34 percent of Mexico's commerce with the U.S. and Canada (more than 0.82 trillion tons), while only 21.7 percent of the total related to Texas commerce with Mexico (more than half a trillion tons). In other words, Texas ports handled nearly 0.3 trillion tons of commodities that were related to other state's commerce with Mexico (see Tables 4.25 and 4.26).

Finally, Tables 4.27 and 4.28 show the major commodity types exported and imported by Mexico using Texas ports. Chemical products, fuels, some grains, soybeans, and some mineral products are the major commodities imported by Mexico from the U.S. and Canada. Raw petroleum and petroleum products, other fuels, cement, and manufactured goods such as tools and shoe soles are the most important commodities exported by Mexico to the U.S. and Canada.

Table 4.24 Mexican waterborne foreign commerce by port (1991)

Port of Origin or Destination	**Imports**		**Exports**	
	Tonnage	**Percent**	**Tonnage**	**Percent**
Beaumont	3.4499E9	0.2	4.411E10	1.4
Brownsville	4.3903E9	0.3	6.0673E8	0.0
Corpus Christi	1.969E10	1.4	8.127E10	2.6
Freeport	1.4821E9	0.1	1.284E10	0.4
Galveston	2.495E10	1.8	3.8451E8	0.0
Houston	1.381E11	9.7	3.696E11	11.7
Port Arthur	7.725E8	0.1	1.14E11	3.6
Victoria	5.1384E9	0.4		
All Other Ports	1.223E12	86.1	2.548E12	80.4
TOTAL	1.420E12	100	3.18E12	100

Table 4.25 Mexican waterborne NAFTA commerce by port (1991)

Export Destination or Import Origin	Imports		Exports	
	Tonnage	Percent	Tonnage	Percent
Beaumont	3.4499E9	0.5	4.411E10	2.7
Brownsville	4.3903E9	0.6	6.0673E8	0.0
Corpus Christi	1.969E10	2.6	8.127E10	4.9
Freeport	1.4821E9	0.2	1.284E10	0.8
Galveston	2.495E10	3.3	3.8451E8	0.0
Houston	1.381E11	18.3	3.696E11	22.3
Port Arthur	7.725E8	0.1	1.14E11	6.9
Other US and Canadian Ports	5.619E11	74.5	1.031E12	62.3
Total NAFTA	7.55E+11	100	1.65E+12	100

Table 4.26 Mexican waterborne NAFTA commerce by location (1991)

Export Destination or Import Origin	Imports		Exports	
	Tonnage	Percent	Tonnage	Percent
ALABAMA	5.0561E9	0.7	3.641E10	2.2
CALIFORNIA	1.488E11	19.7	1.065E11	6.4
DELAWARE			2.311E9	0.1
FLORIDA	8.413E10	11.1	1.666E11	10.1
GEORGIA	5.0181E9	0.7	3.0298E9	0.2
HAWAII			1.27E10	0.8
VIRGIN ISLANDS			4.3838E9	0.3
KENTUCKY			11328500	0.0
LOUISIANA	2.286E11	30.3	1.959E11	11.8
MAINE			6.39E10	3.9
MARYLAND	5.7129E8	0.1	2.2761E9	0.1
MASSACHUSETTS	2.3095E9	0.3		
MISSISSIPPI	5.6743E9	0.8	2.169E10	1.3
NEW JERSEY	3.1243E9	0.4	2.19E10	1.3
NEW YORK	93380500	0.0	4.515E10	2.7
NORTH CAROLINA			2.601E10	1.6
OREGON	1.1002E9	0.1	6846400	0.0
PUERTO RICO	3.3004E9	0.4	2.203E10	1.3
RHODE ISLAND			2.8661E8	0.0
SOUTH CAROLINA	2.6364E9	0.3	3.696E11	22.3
TEXAS	2.059E11	27.3	3.173E11	19.2
VIRGINIA	30317700	0.0	2.315E11	14.0
WASHINGTON	8927700	.0.0		
CANADA	5.841E10	7.7	4.399E9	0.3
Total NAFTA	7.55E+11	100	1.65E+12	100

Table 4.27 Principal commodities at Texas ports (Mexican imports from U.S. and Canada)

Port	Commodity	Tonnage	Percent
BEAUMONT	LUBRICANTS	2.3183E9	67.2
	METHANOL	5.037E8	14.6
	SORGO	3.74E8	10.8
	SOYBEANS	2.5391E8	7.4
BROWNSVILLE	CORN	4.3903E9	100.0
CORPUS_CHRISTI	VINYL CHLORIDE	5.9908E9	30.4
	FUEL OIL	2.5447E9	12.9
	ORTHOXYLEN	1.0288E8	0.5
	SORGO	1.105E10	56.1
FREEPORT	SODA	1.4821E9	100.0
GALVESTON	PARAXYLEN	4.1987E8	1.7
	SORGO	2.145E10	86.0
	WHEAT	3.08E9	12.3
HOUSTON[1]	ISOPROP. ALCOHOL	2.7526E9	2.0
	VINYL CHLORIDE	5.5147E9	4.0
	CORN	2.8798E9	2.1
	METHANOL	3.8618E9	2.8
	PARAXYLEN	1.167E10	8.5
	PROPYLENE	2.7708E9	2.0
	GREASE	6.6774E9	4.8
	SORGO	7.636E10	55.3
	SODA	3.8369E9	2.8
	SOYBEANS	5.9422E9	4.3
	WHEAT	2.64E9	1.9
	OTHER	1.3112E10	9.5
PORT_ARTHUR	MINERAL CARBON	7.725E8	100.0

[1] All commodities amounting to less than 1.5% are included in the "other" category.

Table 4.28 Principal commodities at Texas ports (Mexican exports to U.S. and Canada)

Port	Commodity	Tonnage	Percent
BEAUMONT	EMPTY CONTAINERS	5280000	0.0
	PETROLEUM	4.41E10	100.0
BROWNSVILLE-	EDIBLE OILS	99517100	16.4
	VEGETABLE OILS	100300	0.0
	AUTOS	27801000	4.6
	PETROLEUM PRODUCTS	4.7931E8	79.0
CORPUS_CHRISTI	DIESEL	2.1E9	2.6
	GASOLINE	2.5564E9	3.1
	PETROLEUM	7.43E10	91.4
	PETROLEUM PRODUCTS	66086400	0.1
	JET FUEL	2.2522E9	2.8
FREEPORT	CEMENT	3.29E9	25.6
	VYNIL CHLORIDE	2.0776E8	1.6
	FUEL OIL	4.489E9	35.0
	DIESEL	4.3997E9	34.3
	ETHYLENE	4.5471E8	3.5
GALVESTON	ACIDS	4177600	1.1
	TITAN DIOXIDE	2005000	0.5
	BEER	1.6375E8	42.5
	EMPTY CONTAINERS	1.4898E8	38.7
	TOOLS	22496100	5.8
	POLYETHYLENE	12981000	3.4
	LEATHER SHOE SOLES	2900000	0.8
	WINES	7230000	1.9
	OTHER	19993900	5.2
HOUSTON	BUTANE-PROPANE	6.99E10	18.9
	FUEL OIL	8.6163E9	2.3
	PENTANE	1.03E10	2.8
	PETROLEUM	2.46E11	66.6
	PETROLEUM PRODUCTS	7.3003E9	2.0
	STEEL PIPES	4.6009E9	1.2
	OTHER	2.2917E10	6.2
PORT_ARTHUR	FLUORITE	1.1607E9	1.0
	ENGINES	907200	0.0
	PENTANE	6.0779E9	5.37
	PETROLEUM	1.02E11	89.5
	STEEL PLATES	4.7297E9	4.1

While the maritime transport data obtained in this project refer to a pre-NAFTA situation, they nonetheless underscore Texas' role as a major gateway for NAFTA commerce by sea. It is recommended that more recent data be obtained and used to update the conclusions regarding use of Texas' ports by other states in their commerce with Mexico. As mentioned earlier, TxDOT does not participate in funding Texas ports, but it has to provide and plan for supporting infrastructure, as well as serve the truck demand generated by existent and new ports. Since the data demonstrate that a considerable part of the NAFTA-related waterborne tonnage handled by Texas ports actually has other states as origins and destinations of the commodity, the data can be used by TxDOT to obtain its fair share of transportation infrastructure funding.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

According to a recent report on TxDOT's activities at the Texas-Mexico border, enhancing the viability of multimodal border transportation is an important component of TxDOT's activities, one that is required to relieve the stress on the highway network (Ref 4.15). Prompt availability of up-to-date transportation data on modes other than highway is instrumental in implementing a dynamic transportation planning approach and for demonstrating the need to fund the nation's import/export corridors that utilize Texas' infrastructure.

The Texas-Mexico multimodal data added to the TRANSBORDER data base under Project 2932 can assist TxDOT's multimodal transportation efforts, while at the same time confirming the predominant role of Texas ports, rail infrastructure, and airports in serving NAFTA-related commerce. Even considering that some of the data were collected before NAFTA, the information is sufficient to assert Texas' role as a major gateway for NAFTA commerce in every transportation mode. For example, the data show that:

(1) in 1992, NAFTA commerce by air totaled $2.86 billion, or 45 percent of worldwide total value of Mexican foreign commerce by air;

(2) in 1994, over 15 million tons of rail freight crossed the Texas-Mexico border; this is equivalent to over 71 percent of the rail freight crossing the U.S.-Mexico border;

(3) in 1994, over 243,000 freight rail cars crossed the Texas-Mexico border; this is equivalent to over 68 percent of all rail cars that crossed the U.S.-Mexico border;

(4) in 1991, over 523 billion tons, or less than 22 percent of Mexico's waterborne trade with the U.S. and Canada had origins and destinations in Texas;

(5) in 1991, Texas ports handled over 816 billion tons, or nearly 38 percent of Mexico's waterborne trade with the U.S. and Canada; of these, over 293 billion tons, or over 12 percent, had neither origins nor destinations in Texas.

The data clearly indicate that Texas serves a disproportionate share of NAFTA commerce by all transport modes and consequently sustains a disproportionate share of such problems as congestion, poor air quality, and the environmental problems associated with infrastructure construction required to serve the escalating NAFTA commerce. Periodically updating the data discussed in this chapter is an essential task for effectively planning for this infrastructure. Data summaries that highlight Texas' share in serving other states' commerce with Mexico can provide

TxDOT with the evidence necessary to argue for its fair share of federal funding for NAFTA-related commerce.

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CHAPTER 5. SOCIOECONOMIC DATA

INTRODUCTION AND BACKGROUND

A wealth of socioeconomic data exist both in the U.S. and in Mexico. Sources of U.S. data include, but are not limited to, the U.S. Census Bureau, Texas State Comptroller Data Base, Borderbase at The University of Texas at El Paso (UTEP), city councils and chambers of commerce, private organizations, and numerous reports, theses, and dissertations. Mexican data sources include state and federal organizations, such as the Instituto Nacional de Estadística Geografía e Informatica (INEGI) and Consejo Nacional de Población. The TRANSBORDER data base developed under Study 7-1976 has the following types of socioeconomic information (Ref 5.1):

1. U.S. Socioeconomic Data
    - 1.1. Sales Data
    - 1.2. U.S. Population Data
    - 1.3. U.S. Vehicle Ownership Data

2. Mexican Socioeconomic Data
    - 2.1 Mexican Municipalities Information
    - 2.2 Employment Data
    - 2.3 Mexican Population Data
    - 2.4 Maquiladora Indicators

Census-related data, such as population and employment, are collected every 10 years; the TRANSBORDER data base at this point has the latest information, which should be updated in the year 2000. Numerous other types of data could be added to the TRANSBORDER data base, and it was necessary to determine which information was the most relevant for the study period. After interviews with Customs inspectors, city officials, chamber of commerce personnel on both sides of the border, and maquiladora managers in Ciudad Acuña and Piedras Negras, the following facts emerged:

(1) Retail sales in Texas were significantly affected by the peso devaluation.

(2) Maquiladora production grew after NAFTA, but was not significantly affected by the peso devaluation.

(3) Border traffic demand decreased after the peso devaluation.

The peso devaluation occurred after this study was contracted; therefore, an analysis of the effects of the devaluation was not part of its original objective. Nevertheless, it was important to use this study as an opportunity to assess the impact of this event on Texas traffic demand and economic activity. During meetings with the Project Director and his staff, we decided to focus the analysis on the most recent Texas sales data, with emphasis on comparisons between the periods before and after the peso devaluation.

ANALYSIS OF SALES DATA IN TEXAS

A history of quarterly sales data was available in the TRANSBORDER data base from 1984 to 1992. The data source is the State Comptroller's Office, which has an on-line data base of Texas economic indicators and state revenues. Information includes retail sales, total sales, and number of outlets. In this project, these data were updated to include 1993, 1994, and the first semester of 1995 (the latest data available).

The State Comptroller's office updates its sales tax data files five to six months after the close of a quarter. It takes this long because returns are not due until the 20th of the month following the close of a quarter, and reported information from taxpayers' returns goes through a lengthy verification process to ensure the accuracy of the sales tax data base.

Data Description

Table 5.5 (at the end of this chapter) shows the 1993, 1994, and 1995 quarterly sales data in Texas, which include the cities of Brownsville, Del Rio, Donna, Eagle Pass, Edinburg, El Paso, Harlingen, Hidalgo, La Feria, La Grulla, La Joya, Laredo, Los Fresnos, McAllen, Mercedes, Mission, Pharr, Progreso, Roma, San Benito, San Juan, Socorro, and Weslaco. When fewer than four outlets are reporting in a quarter, the data are omitted as required by state disclosure laws. Sales data for small border towns such as Rio Grande City, Fabens, and Presidio are not reported by the Comptroller's Office. These omissions are marked in with an asterisk (*) in the gross sales and amount subject to tax data fields. The actual number of reporting outlets is listed. The city of Progreso is shown in Table 5.5 as an example of partially unreported data.

The sales tax report shows total sales and retail sales for the first quarter of 1993 through the latest available quarter (second quarter of 1995). The data show gross sales, amount subject to state sales tax, and the number of reporting outlets by quarter, as reported to the State Comptroller's Office by the taxpayers in the selected city.

Data Reduction

In order to summarize the data, small cities located near larger urban concentrations were pooled together, under the name of the nearest larger city. The sales values and outlets were aggregated by the areas shown in Table 5.1. While the Hidalgo/McAllen area comprises the larger number of cities, the largest share of sales is reported by the El Paso area (El Paso and Socorro).

The State Comptroller's Office reports sales in nominal dollars of each year; and since this is not consistent for research purposes, all sales values were converted to 1995 dollars. The Consumer Price Index (CPI) was used to convert the nominal dollars of each reported year to the baseline year of 1995 (an average inflation rate of about 2 percent). The values of CPI were obtained from the Economic Indicators Handbook and are based on the average of all U.S. urban consumers.

Table 5.1 Sales data aggregation for analysis purposes

Area Name	Cities Included
Brownsville	Brownsville, Los Fresnos
Harlingen	Harlingen, San Benito, Weslaco
Hidalgo/McAllen	Hidalgo, McAllen, Donna, Edinburg, La Feria, La Joya, Mercedes, Mission, Pharr, San Juan, Progreso Lakes
Roma	Roma Los Saenz, La Grulla
Laredo	Laredo
Eagle Pass	Eagle Pass
Del Rio	Del Rio
El Paso	El Paso, Socorro

Peso Devaluation Effects on Sales

Sales data for the first two quarters of 1993, 1994, and 1995 were pooled and used in the analyses discussed in this section. The third and fourth quarters were not examined, since 1995 data are available only for the first two quarters. The sales data were examined in two ways: borderwide and by the areas depicted in Table 5.1.

Table 5.2 shows the borderwide retail and total sales in 1995 dollars for the first six months of 1993, 1994, and 1995. Between 1993 and 1994, the number of retail outlets increased over 7.6 percent, from nearly 28,500 to over 30,600, borderwide. Total outlets (including whole sales) increased over 8 percent, from more than 46,100 to almost 49,900. Total value of retail sales increased from nearly $5.7 billion in 1993 to almost $6 billion in 1994, reaching an almost 6 percent increase. Total sales increased more than twice the rate of retail sales: 14.5 percent, from over $10.8 billion to almost $12.5 billion.

The peso devaluation considerably affected these trends. The number of outlets (retail and total) remained almost the same, growing 0.3 percent or less between 1994 and 1995. The amount sold decreased considerably: an almost 12.5 percent drop in retail sales and a 9 percent drop in total sales, borderwide.

Table 5.2 Borderwide sales evolution

Year	Number of Outlets		Sales (millions of 1995 dollars)	
	Retail	Total	Retail	Total
1993	28,462	46,153	5,651	10,875
1994	30,629	49,890	5,984	12,450
1995	30,700	50,040	5,240	11,326
Year	**Outlets Growth**		**Sales Growth**	
1994	7.61%	8.10%	5.91%	14.49%
1995	0.23%	0.30%	-12.44%	-9.03%

The sales trends differ from area to area, as shown in Figures 5.1 through 5.4. Figures 5.1 and 5.2, respectively, show the evolution of retail and total sales within the major areas of the

Texas-Mexico border. Figures 5.3 and 5.4 show the evolution in number of sales outlets, respectively, for retail and total sales within each area.

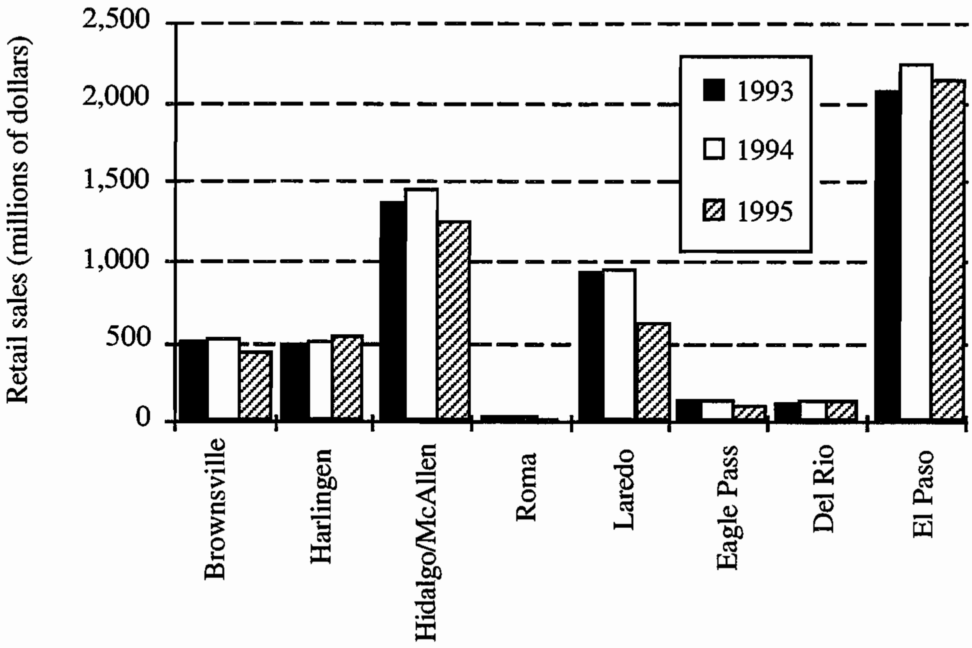

Figure 5.1 Retail sales evolution by area

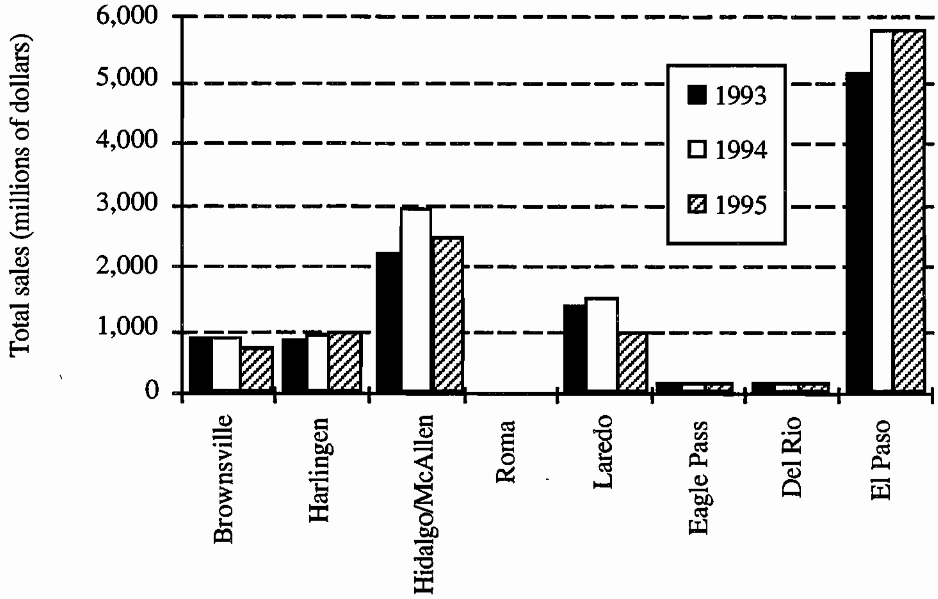

Figure 5.2 Total sales evolution by area

El Paso has the largest sales activity of the border, averaging over $2.1 billion in retail sales and $5.5 billion in total sales in the past 3 years. The Hidalgo/McAllen area ranks second, with retail sales in the neighborhood of $1.4 billion, and total sales around $2.6 billion. Laredo is third, with an average of $950 million in retail sales and $1.5 billion in total sales for 1993 and 1994.

In 1995, Laredo's retail sales dropped to slightly over $600 million, while total sales dropped to $984 million. This was the most significant impact of the peso devaluation, which represents a drop of almost 36.5 percent in retail sales and a drop of over 35.5 percent in total sales.

Eagle Pass sustained the second worst retail sales decline after the devaluation, with a drop of over 20 percent, from $139 million in 1994 to $111 million in 1995. Roma ranks second in total sales losses, with a 17 percent decrease. While El Paso has the largest share of sales revenues on the Texas-Mexico border, the effects of the peso devaluation kept the 1995 total sales at 1994 levels, while retail sales decreased more than 4 percent. Harlingen was the only area in which sales grew after the devaluation; moreover, Harlingen's total sales increased more over the 1994-1995 period (8.8 percent) than in the previous period (5.3 percent). Table 5.3 summarizes the sales growth within the major Texas-Mexico border areas.

Table 5.3 Sales growth along the Texas-Mexico border

Area	Period	Retail Sales Growth	Total Sales Growth
Brownsville	1993-1994	4.03%	0.47%
	1994-1995	-19.39%	-15.02%
Del Rio	1993-1994	5.87%	15.09%
	1994-1995	-2.93%	-7.26%
Eagle Pass	1993-1994	3.01%	5.67%
	1994-1995	-20.05%	-6.56%
El Paso	1993-1994	8.44%	13.15%
	1994-1995	-4.10%	-0.31%
Harlingen	1993-1994	8.16%	5.33%
	1994-1995	5.74%	8.77%
Hidalgo/McAllen	1993-1994	6.02%	31.15%
	1994-1995	-13.47%	-16.25%
Laredo	1993-1994	0.69%	7.89%
	1994-1995	-36.43%	-35.57%
Roma	1993-1994	-0.86%	4.69%
	1994-1995	-15.48%	-17.27%

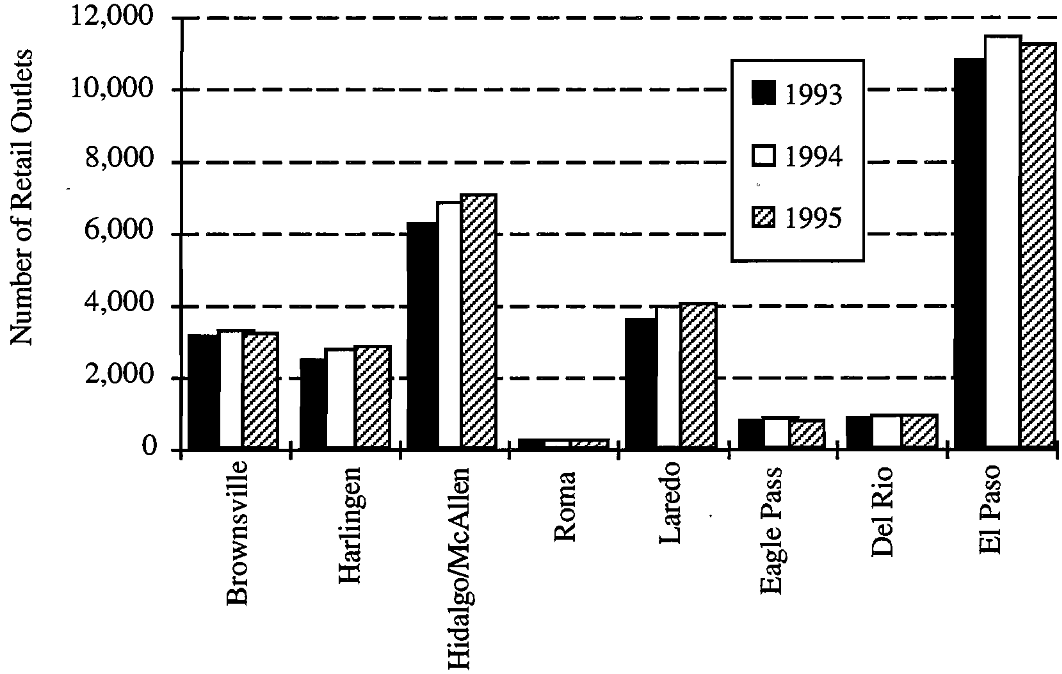

Figure 5.3 Retail outlets evolution by area

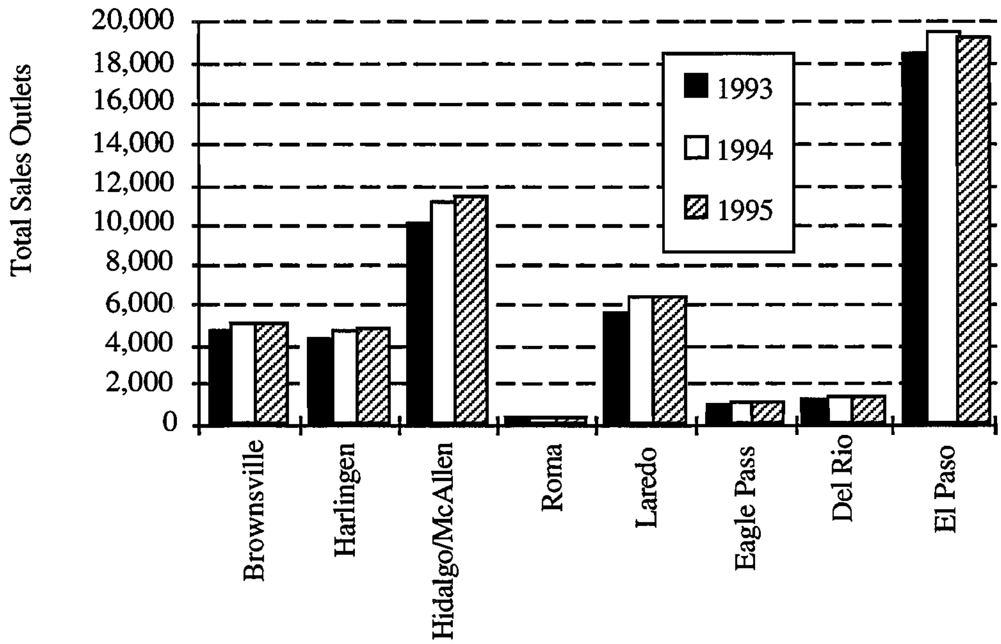

Figure 5.4 Total sale outlets evolution by area

These significant decreases in the total volume of sales caused some business closures, although at percentage rates less impressive than those observed for the revenues. Table 5.4 shows a summary of the impact of the peso devaluation on the number of sale outlets in each border area.

Over the 1994-1995 period, the number of sale outlets increased in the Laredo, Del Rio, and Hidalgo/McAllen areas, in spite of the drop in sales. In Harlingen, the only border area where sales increased after the peso devaluation, the number of outlets increased around 2.8 percent, significantly less than the 10.7 and 8.6 percent increases observed, respectively, for retail and total outlets during the previous period. In Brownsville and El Paso there was a decrease in the number of sales outlets, while in Eagle Pass the number remained nearly the same (0.12 percent decrease for retail outlets, and less than 0.005 percent decrease for total outlets). Roma showed a decrease in retail outlets and an increase in total outlets, indicating a relative increase in wholesale activity. Roma is the only border area in which the number of outlets increased more in the 1994-1995 period than in the 1993-1994 period.

Table 5.4 Growth in number of outlets along the Texas-Mexico border

Area	Period	Retail Outlets Growth	Total Outlets Growth
Brownsville	1993-1994	6.69%	9.12%
	1994-1995	-1.16%	-1.40%
Del Rio	1993-1994	1.56%	5.90%
	1994-1995	0.77%	0.84%
Eagle Pass	1993-1994	6.62%	9.28%
	1994-1995	-0.12%	0.00%
El Paso	1993-1994	6.22%	6.15%
	1994-1995	-1.82%	-1.32%
Harlingen	1993-1994	10.65%	8.59%
	1994-1995	2.72%	2.84%
Hidalgo/McAllen	1993-1994	8.72%	9.43%
	1994-1995	3.06%	2.73%
Laredo	1993-1994	10.99%	11.70%
	1994-1995	0.77%	0.33%
Roma	1993-1994	-1.34%	-1.06%
	1994-1995	-1.69%	2.95%

CONCLUSIONS AND RECOMMENDATIONS

Texas sales data are an important indicator of transborder economic activity. The available data indicate the significant impact of the peso devaluation over the entire border, except within the Harlingen area. The numbers discussed in this chapter confirm the information obtained during interviews with chambers of commerce and city representatives conducted during the first semester of 1995, when the 1995 data were not yet available. These interviews indicated that shopping decreased considerably, but had not caused a significant number of businesses to collapse. According to most of those interviewed, retailers along the border preferred to downsize and wait for the worst effects to subside. Most persons interviewed were optimistic about the Mexican economy's quick recovery, and were expecting the sales to return to normal levels immediately after recovery. A follow-up analysis of the 1995-1996 data is recommended to verify the mid-term impacts of the peso devaluation.

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Table 5.5 Recent Texas sales data (nominal dollars)

City of Brownsville Total Sales				
1993	Q1	400,716,370	151,338,193	2,273
	Q2	422,849,110	161,871,837	2,335
	Q3	428,365,006	169,215,098	2,423
	Q4	560,866,290	184,177,783	3,061
		===============	===============	
		1,812,796,776	666,602,911	
1994	Q1	416,310,339	160,668,842	2,503
	Q2	426,326,088	166,159,765	2,520
	Q3	411,273,052	173,008,630	2,494
	Q4	498,723,724	183,201,363	2,702
		===============	===============	
		1,752,633,203	683,038,600	
1995	Q1	355,220,360	139,955,813	2,511
	Q2	372,408,392	149,162,672	2,432
City of Brownsville Retail Sales				
1993	Q1	234,887,619	118,044,056	1,535
	Q2	249,095,191	128,647,110	1,562
	Q3	251,199,024	133,321,056	1,615
	Q4	297,788,939	147,670,448	1,949
		===============	===============	
		1,032,970,773	527,682,670	
1994	Q1	249,406,682	127,654,460	1,644
	Q2	263,950,529	133,352,576	1,655
	Q3	262,653,997	138,767,822	1,643
	Q4	292,481,766	149,007,280	1,756
		===============	===============	
		1,068,492,974	548,782,138	
1995	Q1	207,227,527	108,694,316	1,651
	Q2	213,743,767	117,351,301	1,607

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Hidalgo Total Sales					
	1993	Q1	21,525,488	3,684,987	148
		Q2	20,455,507	3,179,626	151
		Q3	24,836,622	3,219,405	153
		Q4	42,479,826	3,563,048	215
			===============	===============	
			109,297,443	13,647,066	
	1994	Q1	35,572,168	2,903,123	160
		Q2	40,319,607	2,798,255	158
		Q3	19,394,823	2,839,574	162
		Q4	47,203,875	2,871,088	178
			===============	===============	
			142,490,473	11,412,040	
	1995	Q1	10,515,096	1,993,652	142
		Q2	11,543,527	2,099,999	131
City of Hidalgo Retail Sales					
	1993	Q1	16,663,493	3,480,212	114
		Q2	18,864,741	2,997,392	112
		Q3	18,680,958	2,979,936	115
		Q4	24,212,024	3,284,390	154
			===============	===============	
			78,421,216	12,741,930	
	1994	Q1	20,546,008	2,742,694	120
		Q2	21,161,748	2,674,906	118
		Q3	17,814,537	2,675,727	122
		Q4	22,170,318	2,690,441	131
			===============	===============	
			81,692,611	10,783,768	
	1995	Q1	9,993,909	1,858,786	116
		Q2	10,938,836	1,975,762	109

Table columns are: year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Eagle Pass Total Sales				
1993	Q1	74,666,564	38,323,646	525
	Q2	80,911,120	42,411,148	542
	Q3	85,335,574	41,698,988	554
	Q4	105,744,966	51,666,386	741
		===============	===============	
		346,658,224	174,100,168	
1994	Q1	82,368,623	41,725,026	575
	Q2	85,320,825	44,072,705	591
	Q3	84,279,613	43,371,334	575
	Q4	107,320,107	52,443,870	640
		===============	===============	
		359,289,168	181,612,935	
1995	Q1	75,376,131	33,528,085	588
	Q2	84,446,544	37,173,004	578
City of Eagle Pass Retail Sales				
1993	Q1	62,680,285	35,498,016	389
	Q2	67,164,578	39,433,095	396
	Q3	67,052,441	38,794,135	400
	Q4	81,675,102	48,347,236	502
		===============	===============	
		278,572,406	162,072,482	
1994	Q1	66,588,516	38,536,682	411
	Q2	69,836,276	41,032,950	426
	Q3	67,274,619	40,387,420	419
	Q4	77,027,471	48,851,036	454
		===============	===============	
		280,726,882	168,808,088	
1995	Q1	53,491,776	30,512,203	424
	Q2	57,758,558	33,876,548	412

Table columns are: year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Del Rio Total Sales				
1993	Q1	74,374,513	35,621,241	672
	Q2	79,129,249	39,774,336	685
	Q3	80,183,127	39,759,834	685
	Q4	125,416,190	45,205,540	949
		===============	===============	
		359,103,079	160,360,951	
1994	Q1	85,388,586	38,846,161	718
	Q2	94,805,922	43,678,945	719
	Q3	97,978,485	42,872,952	717
	Q4	171,467,052	48,316,496	865
		===============	===============	
		449,640,045	173,714,554	
1995	Q1	86,553,549	38,002,553	729
	Q2	83,908,357	42,806,885	720
City of Del Rio Retail Sales				
1993	Q1	58,133,594	29,753,814	446
	Q2	60,829,786	33,513,320	449
	Q3	61,286,573	33,471,579	446
	Q4	69,599,936	38,346,943	594
		===============	===============	
		249,849,889	135,085,656	
1994	Q1	59,577,521	32,188,338	456
	Q2	68,884,142	36,131,260	453
	Q3	67,724,962	35,598,252	455
	Q4	73,223,759	40,961,702	548
		===============	===============	
		269,410,384	144,879,552	
1995	Q1	61,055,569	31,256,672	460
	Q2	66,135,973	35,498,216	456

Table columns are: year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets

Table 5.5 Continued

City of Laredo Total Sales				
	1993 Q1	666,808,983	219,759,516	2,800
	Q2	693,355,380	235,591,019	2,911
	Q3	707,788,095	238,232,738	2,973
	Q4	1,143,896,610	293,878,925	4,223
		===============	===============	
		3,211,849,068	987,462,198	
	1994 Q1	720,698,303	242,218,606	3,152
	Q2	776,085,255	260,096,393	3,227
	Q3	733,441,839	262,767,670	3,195
	Q4	932,849,247	305,375,256	3,596
		===============	===============	
		3,163,074,644	1,070,457,925	
	1995 Q1	477,115,405	198,055,864	3,203
	Q2	506,476,189	216,046,131	3,197
City of Laredo Retail Sales				
	1993 Q1	449,576,068	179,343,439	1,771
	Q2	464,208,407	192,810,539	1,842
	Q3	470,134,948	196,232,400	1,878
	Q4	584,262,971	244,291,734	2,579
		===============	===============	
		1,968,182,394	812,678,112	
	1994 Q1	462,913,157	196,194,939	1,985
	Q2	475,611,111	207,538,681	2,025
	Q3	454,538,907	210,027,374	2,005
	Q4	529,480,976	249,543,426	2,237
		===============	===============	
		1,922,544,151	863,304,420	
	1995 Q1	296,270,165	155,107,207	2,007
	Q2	312,248,733	170,237,557	2,034

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of El Paso Total Sales				
	1993 Q1	2,402,621,655	746,490,420	8,963
	Q2	2,510,096,462	821,904,989	9,200
	Q3	2,664,199,510	832,689,861	9,235
	Q4	3,622,926,834	943,718,988	15,342
		===============	===============	
		11,199,844,461	3,344,804,258	
	1994 Q1	2,650,250,037	785,579,730	9,603
	Q2	3,004,034,122	863,200,795	9,691
	Q3	3,142,472,770	881,206,431	9,645
	Q4	4,285,248,728	985,013,168	13,003
		===============	===============	
		13,082,005,657	3,515,000,124	
	1995 Q1	2,948,878,822	774,913,548	9,631
	Q2	2,817,962,866	858,801,626	9,424
City of El Paso Retail Sales				
	1993 Q1	957,098,206	509,029,699	5,218
	Q2	1,016,761,459	561,251,893	5,382
	Q3	1,074,743,129	564,929,364	5,380
	Q4	1,364,223,511	671,183,093	9,313
		===============	===============	
		4,412,826,305	2,306,394,049	
	1994 Q1	1,026,059,194	534,222,804	5,611
	Q2	1,149,412,673	592,355,085	5,653
	Q3	1,160,574,175	602,374,098	5,622
	Q4	1,395,801,681	704,470,483	7,864
		===============	===============	
		4,731,847,723	2,433,422,470	
	1995 Q1	1,013,348,293	522,163,385	5,604
	Q2	1,113,413,559	592,065,824	5,457

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Donna Total Sales				
	1993 Q1	35,413,851	5,413,890	188
	Q2	33,057,313	5,437,796	177
	Q3	30,249,384	5,279,502	189
	Q4	38,333,324	6,151,431	361
		===============	===============	
		137,053,872	22,282,619	
	1994 Q1	40,627,656	6,397,315	237
	Q2	33,289,022	6,147,900	203
	Q3	31,738,267	5,453,716	207
	Q4	23,808,843	6,272,928	302
		===============	===============	
		129,463,788	24,271,859	
	1995 Q1	23,033,032	6,538,776	223
	Q2	18,096,488	5,986,250	184
City of Donna Retail Sales				
	1993 Q1	9,222,542	3,831,594	128
	Q2	9,659,010	3,982,578	118
	Q3	8,729,640	3,764,349	122
	Q4	11,809,739	4,484,746	248
		===============	===============	
		39,420,931	16,063,267	
	1994 Q1	12,611,908	4,703,228	161
	Q2	10,794,526	4,341,930	134
	Q3	9,224,027	3,733,851	137
	Q4	13,561,363	4,552,380	205
		===============	===============	
		46,191,824	17,331,389	
	1995 Q1	15,141,817	4,796,286	149
	Q2	10,506,484	4,372,761	118

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Edinburg Total Sales				
1993	Q1	101,956,787	35,701,768	557
	Q2	106,275,400	36,154,884	588
	Q3	100,990,865	36,949,042	598
	Q4	126,533,335	39,091,354	836
		===============	===============	
		435,756,387	147,897,048	
1994	Q1	111,709,495	38,688,211	613
	Q2	116,051,513	39,114,561	636
	Q3	106,963,614	38,676,573	637
	Q4	123,978,268	40,804,044	713
		===============	===============	
		458,702,890	157,283,389	
1995	Q1	120,997,514	38,208,066	637
	Q2	124,203,083	39,371,084	623
1993	Q1	62,283,592	29,420,551	337
	Q2	64,572,880	29,762,425	362
	Q3	63,997,863	30,161,202	356
	Q4	67,830,340	32,240,192	486
		===============	===============	
		258,684,675	121,584,370	
City of Edinburg Retail Sales				
1994	Q1	68,232,654	31,562,184	372
	Q2	68,725,868	31,999,807	387
	Q3	64,451,427	31,406,052	382
	Q4	68,168,355	33,867,830	426
		===============	===============	
		269,578,304	128,835,873	
1995	Q1	69,060,132	31,272,560	377
	Q2	69,862,808	31,858,988	373

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Harlingen Total Sales				
	1993 Q1	256,845,525	120,358,988	1,369
	Q2	258,762,721	123,027,813	1,370
	Q3	280,149,340	126,940,023	1,413
	Q4	347,189,089	141,150,709	1,826
		===============	===============	
		1,142,946,675	511,477,533	
	1994 Q1	281,257,824	129,246,562	1,495
	Q2	274,424,020	131,998,227	1,495
	Q3	291,598,128	134,876,941	1,523
	Q4	319,539,734	151,028,572	1,682
		===============	===============	
		1,166,819,706	547,150,302	
	1995 Q1	290,727,693	132,195,418	1,560
	Q2	299,499,262	136,605,675	1,533
City of Harlingen Retail Sales				
	1993 Q1	132,434,389	83,935,181	766
	Q2	132,920,797	84,778,899	771
	Q3	144,597,706	88,698,423	805
	Q4	172,541,925	103,034,673	1,033
		===============	===============	
		582,494,817	360,447,176	
	1994 Q1	145,502,060	90,457,756	855
	Q2	146,748,329	90,659,232	848
	Q3	152,861,718	93,156,669	867
	Q4	168,308,697	109,663,699	956
		===============	===============	
		613,420,804	383,937,356	
	1995 Q1	157,360,773	89,533,471	889
	Q2	155,846,911	92,454,033	895

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of La Feria Total Sales				
1993	Q1	5,980,427	2,285,199	64
	Q2	5,867,678	2,101,001	64
	Q3	5,804,090	1,965,264	64
	Q4	6,445,804	2,258,175	98
		===============	===============	
		24,097,999	8,609,639	
1994	Q1	6,455,434	2,377,141	67
	Q2	6,843,495	1,998,259	68
	Q3	6,406,488	2,160,039	65
	Q4	5,844,450	2,130,948	85
		===============	===============	
		25,549,867	8,666,387	
1995	Q1	6,098,286	2,217,902	64
	Q2	6,262,612	2,100,477	67
City of La Feria Retail Sales				
1993	Q1	3,333,180	1,613,735	37
	Q2	3,016,733	1,383,032	38
	Q3	2,932,469	1,330,037	38
	Q4	3,593,626	1,487,457	54
		===============	===============	
		12,876,008	5,814,261	
1994	Q1	3,497,506	1,558,109	38
	Q2	3,074,084	1,308,694	42
	Q3	3,175,786	1,346,384	40
	Q4	3,562,273	1,451,379	50
		===============	===============	
		13,309,649	5,664,566	
1995	Q1	3,515,047	1,541,616	38
	Q2	3,382,833	1,416,901	43

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of La Grulla Total Sales				
1993	Q1	860,669	99,025	10
	Q2	288,793	96,089	11
	Q3	251,778	83,933	9
	Q4	235,268	80,843	13
		===============	===============	
		1,636,508	359,890	
1994	Q1	259,406	77,895	8
	Q2	269,053	72,727	9
	Q3	251,280	67,139	9
	Q4	268,659	74,553	11
		===============	===============	
		1,048,398	292,314	
1995	Q1	258,298	73,686	7
	Q2	253,013	69,681	8
City of La Grulla Retail Sales				
1993	Q1	860,669	99,025	10
	Q2	288,793	96,089	11
	Q3	251,778	83,933	9
	Q4	231,988	77,563	11
		===============	===============	
		1,633,228	356,610	
1994	Q1	259,406	77,895	8
	Q2	269,053	72,727	9
	Q3	251,280	67,139	7
	Q4	268,659	74,553	9
		===============	===============	
		1,048,398	292,314	
1995	Q1	258,298	73,686	7
	Q2	253,013	69,681	8

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of La Joya Total Sales				
	1993 Q1	1,244,590	601,873	26
	Q2	1,360,267	678,807	29
	Q3	1,481,253	882,001	27
	Q4	1,652,683	1,026,290	38
		===============	===============	
		5,738,793	3,188,971	
	1994 Q1	1,699,076	1,019,340	29
	Q2	1,702,066	1,043,342	30
	Q3	1,750,422	1,263,176	31
	Q4	1,722,721	1,159,782	39
		===============	===============	
		6,874,285	4,485,640	
	1995 Q1	1,496,324	961,479	33
	Q2	1,739,983	1,072,590	34
City of La Joya Retail Sales				
	1993 Q1	887,141	260,373	22
	Q2	953,265	292,812	23
	Q3	969,830	405,318	21
	Q4	1,112,415	496,517	28
		===============	===============	
		3,922,651	1,455,020	
	1994 Q1	1,156,007	486,315	24
	Q2	1,148,544	498,758	25
	Q3	1,162,017	687,386	27
	Q4	1,173,274	624,051	31
		===============	===============	
		4,639,842	2,296,510	
	1995 Q1	1,160,136	636,156	27
	Q2	1,250,336	646,028	27

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Los Fresnos Total Sales				
1993	Q1	3,693,162	2,219,905	53
	Q2	4,175,381	2,605,888	53
	Q3	4,383,723	2,701,231	51
	Q4	5,558,346	2,676,838	69
		===============	===============	
		17,810,612	10,203,862	
1994	Q1	4,678,566	2,657,580	61
	Q2	4,756,597	3,007,463	60
	Q3	4,833,346	2,896,466	61
	Q4	4,824,430	2,889,976	64
		===============	===============	
		19,092,939	11,451,485	
1995	Q1	6,237,777	2,853,479	67
	Q2	4,662,540	2,779,938	62
City of Los Fresnos Retail Sales				
1993	Q1	2,807,470	1,589,377	29
	Q2	2,989,637	1,693,019	28
	Q3	3,094,712	1,873,173	27
	Q4	3,101,134	1,820,843	36
		===============	===============	
		11,992,953	6,976,412	
1994	Q1	3,081,983	1,803,106	33
	Q2	3,280,225	1,977,894	33
	Q3	3,282,697	1,861,354	32
	Q4	3,303,800	1,951,067	37
		===============	===============	
		12,948,705	7,593,421	
1995	Q1	3,221,508	1,786,043	36
	Q2	3,137,580	1,791,600	32

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of McAllen Total Sales				
1993	Q1	677,426,664	282,673,472	2,684
	Q2	705,967,873	286,707,053	2,733
	Q3	693,503,549	295,348,150	2,794
	Q4	1,417,654,642	355,105,911	3,884
		===============	===============	
		3,494,552,728	1,219,834,586	
1994	Q1	1,040,068,210	297,960,076	2,938
	Q2	941,703,695	297,135,577	2,911
	Q3	988,032,399	308,757,009	2,931
	Q4	1,561,578,658	360,565,825	3,529
		===============	===============	
		4,531,382,962	1,264,418,487	
1995	Q1	832,576,696	260,235,043	3,043
	Q2	808,699,729	268,330,468	2,948
City of McAllen Retail Sales				
1993	Q1	424,549,299	242,321,667	1,660
	Q2	425,290,782	245,271,435	1,669
	Q3	435,192,202	254,602,158	1,715
	Q4	559,562,656	310,678,712	2,288
		===============	===============	
		1,844,594,939	1,052,873,972	
1994	Q1	453,339,800	255,328,279	1,779
	Q2	454,291,561	253,206,582	1,764
	Q3	459,256,654	263,695,796	1,769
	Q4	554,469,850	313,203,673	2,118
		===============	===============	
		1,921,357,865	1,085,434,330	
1995	Q1	379,647,119	216,543,267	1,856
	Q2	385,880,692	223,596,867	1,817

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Mercedes Total Sales				
1993	Q1	43,260,306	6,502,893	198
	Q2	38,334,515	6,184,243	188
	Q3	38,693,616	6,437,796	195
	Q4	41,037,241	6,574,547	361
		===============	===============	
		161,325,678	25,699,479	
1994	Q1	40,054,517	6,506,940	205
	Q2	38,991,223	6,917,333	208
	Q3	42,472,620	6,681,705	201
	Q4	44,336,022	7,054,880	316
		===============	===============	
		165,854,382	27,160,858	
1995	Q1	41,016,194	6,963,855	223
	Q2	40,860,981	6,816,206	215
City of Mercedes Retail Sales				
1993	Q1	11,914,182	3,924,065	133
	Q2	10,451,780	3,838,384	130
	Q3	10,002,716	3,719,662	137
	Q4	11,144,708	3,857,532	257
		===============	===============	
		43,513,386	15,339,643	
1994	Q1	10,560,291	3,806,979	140
	Q2	11,651,006	4,016,008	145
	Q3	11,523,732	3,648,562	138
	Q4	13,455,581	4,033,888	217
		===============	===============	
		47,190,610	15,505,437	
1995	Q1	14,593,703	4,565,825	149
	Q2	13,652,468	4,477,254	142

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Mission Total Sales				
	1993 Q1	90,225,129	44,636,502	516
	Q2	89,787,471	38,204,237	468
	Q3	80,764,789	36,086,831	471
	Q4	94,929,666	40,725,510	758
		===============	===============	
		355,707,055	159,653,080	
	1994 Q1	94,134,592	41,430,141	535
	Q2	85,326,378	38,615,133	486
	Q3	82,869,678	36,844,793	486
	Q4	98,241,244	43,639,078	696
		===============	===============	
		360,571,892	160,529,145	
	1995 Q1	96,924,972	41,467,991	592
	Q2	88,488,680	38,195,769	511
City of Mission Retail Sales				
	1993 Q1	67,787,393	35,186,822	329
	Q2	65,984,114	31,517,217	299
	Q3	59,463,670	30,331,495	299
	Q4	68,338,599	35,705,756	447
		===============	===============	
		261,573,776	132,741,290	
	1994 Q1	67,145,905	36,011,715	329
	Q2	63,285,309	32,897,394	305
	Q3	58,508,942	30,797,819	304
	Q4	70,660,009	37,311,939	425
		===============	===============	
		259,600,165	137,018,867	
	1995 Q1	70,036,851	35,537,222	364
	Q2	62,793,568	32,378,691	312

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Pharr Total Sales				
	1993 Q1	85,267,232	42,180,251	585
	Q2	88,221,372	41,779,840	573
	Q3	93,228,251	41,367,178	586
	Q4	122,066,539	46,831,487	846
		===============	===============	
		388,783,394	172,158,756	
	1994 Q1	127,864,866	44,022,489	640
	Q2	115,600,533	42,913,423	719
	Q3	111,201,437	43,331,478	720
	Q4	137,148,358	48,353,530	853
		===============	===============	
		491,815,194	178,620,920	
	1995 Q1	105,867,436	44,048,949	765
	Q2	108,873,241	45,539,208	680
City of Pharr Retail Sales				
	1993 Q1	54,760,366	32,407,024	356
	Q2	56,757,319	32,972,255	360
	Q3	57,936,140	32,524,336	373
	Q4	78,873,846	37,425,794	525
		===============	===============	
		248,327,671	135,329,409	
	1994 Q1	69,182,482	34,093,666	398
	Q2	70,295,632	33,557,337	477
	Q3	72,588,793	34,109,948	480
	Q4	92,153,611	37,584,246	559
		===============	===============	
		304,220,518	139,345,197	
	1995 Q1	58,824,425	33,387,560	489
	Q2	62,324,045	33,743,781	442

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of San Benito Total Sales				
	1993 Q1	44,711,198	17,972,298	291
	Q2	46,883,687	18,107,059	299
	Q3	50,012,696	18,689,317	294
	Q4	73,554,913	18,835,716	395
		===============	===============	
		215,162,494	73,604,390	
	1994 Q1	48,855,660	19,318,723	315
	Q2	43,364,020	19,692,779	307
	Q3	43,152,834	19,286,726	316
	Q4	73,852,360	20,835,848	347
		===============	===============	
		209,224,874	79,134,076	
	1995 Q1	55,957,410	21,267,365	324
	Q2	57,923,754	21,041,821	328
City of San Benito Retail Sales				
	1993 Q1	24,917,618	13,853,033	182
	Q2	25,214,938	13,774,967	185
	Q3	25,894,761	14,155,407	186
	Q4	27,347,962	14,648,821	241
		===============	===============	
		103,375,279	56,432,228	
	1994 Q1	29,923,952	15,107,783	203
	Q2	29,650,696	15,611,116	196
	Q3	28,339,736	15,269,548	207
	Q4	31,931,714	16,772,349	213
		===============	===============	
		119,846,098	62,760,796	
	1995 Q1	31,633,602	16,366,377	202
	Q2	31,208,939	16,714,886	205

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of San Juan Total Sales				
1993	Q1	16,238,323	6,064,413	161
	Q2	16,337,579	5,771,978	167
	Q3	18,388,131	5,810,876	177
	Q4	26,465,585	6,490,731	268
		===============	===============	
		77,429,618	24,137,998	
1994	Q1	20,686,627	6,362,190	194
	Q2	20,876,649	6,794,481	190
	Q3	20,756,731	6,870,447	195
	Q4	25,154,677	6,789,212	248
		===============	===============	
		87,474,684	26,816,330	
1995	Q1	24,848,987	6,498,250	213
	Q2	22,915,619	6,956,995	198
City of San Juan Retail Sales				
1993	Q1	7,221,911	3,476,473	97
	Q2	7,199,645	3,421,608	102
	Q3	7,075,249	3,187,301	107
	Q4	13,705,239	3,527,089	156
		===============	===============	
		35,202,044	13,612,471	
1994	Q1	8,785,230	3,672,914	116
	Q2	9,215,541	3,680,263	111
	Q3	7,907,296	3,587,648	114
	Q4	10,739,636	3,855,080	149
		===============	===============	
		36,647,703	14,795,905	
1995	Q1	9,353,287	3,810,511	129
	Q2	10,157,696	3,787,066	120

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Socorro Total Sales				
1993	Q1	11,346,117	2,682,748	152
	Q2	10,789,473	3,193,292	159
	Q3	19,624,967	3,777,207	159
	Q4	18,176,853	3,732,590	224
		===============	===============	
		59,937,410	13,385,837	
1994	Q1	21,761,204	3,489,764	157
	Q2	19,668,330	3,998,670	160
	Q3	11,764,733	4,126,618	157
	Q4	12,947,413	3,894,375	181
		===============	===============	
		66,141,680	15,509,427	
1995	Q1	11,970,175	3,804,282	152
	Q2	12,626,801	4,414,974	146
City of Socorro Retail Sales				
1993	Q1	6,195,722	2,403,462	118
	Q2	6,426,318	2,894,599	121
	Q3	9,947,839	3,520,829	123
	Q4	10,266,628	3,460,243	168
		===============	===============	
		32,836,507	12,279,133	
1994	Q1	10,697,191	3,240,361	123
	Q2	11,134,053	3,758,421	126
	Q3	11,244,806	3,876,730	126
	Q4	11,573,794	3,624,405	137
		===============	===============	
		44,649,844	14,499,917	
1995	Q1	11,114,827	3,284,197	124
	Q2	11,564,281	3,817,349	119

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Weslaco Total Sales				
1993	Q1	102,256,978	43,599,238	429
	Q2	98,911,320	41,798,825	419
	Q3	99,370,789	39,774,111	430
	Q4	119,792,418	45,145,571	646
		===============	===============	
		420,331,505	170,317,745	
1994	Q1	112,639,281	45,128,784	467
	Q2	107,354,750	44,894,618	461
	Q3	110,965,566	47,230,629	458
	Q4	135,161,775	51,406,214	572
		===============	===============	
		466,121,372	188,660,245	
1995	Q1	144,619,324	47,722,337	477
	Q2	116,539,569	46,293,615	455
City of Weslaco Retail Sales				
1993	Q1	69,036,765	35,161,649	272
	Q2	65,120,867	33,324,646	275
	Q3	63,367,173	31,575,020	279
	Q4	73,249,663	36,136,126	394
		===============	===============	
		270,774,468	136,197,441	
1994	Q1	73,923,662	36,109,748	305
	Q2	70,730,067	34,748,866	308
	Q3	70,658,671	38,693,542	309
	Q4	83,717,380	42,234,186	349
		===============	===============	
		299,029,780	151,786,342	
1995	Q1	81,228,261	39,208,250	302
	Q2	78,381,216	37,875,992	297

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Progreso Lakes--Total Sales				
	1993 Q1	502,244	170,500	5
	Q2	523,462	127,403	6
	Q3	478,925	129,832	5
	Q4	541,790	177,740	8
		===============	===============	
		2,046,421	605,475	
	1994 Q1	518,535	187,087	7
	Q2	507,402	136,830	6
	Q3	445,221	115,516	6
	Q4	518,363	159,733	11
		===============	===============	
		1,989,521	599,166	
	1995 Q1	525,923	148,559	7
	Q2	397,719	108,945	6
City of Progreso Lakes--Retail Sales				
	1993 Q1	*	*	2
	Q2	*	*	3
	Q3	*	*	2
	Q4	443,399	103,406	4
		===============	===============	
		443,399	103,406	
	1994 Q1	431,299	105,299	4
	Q2	*	*	3
	Q3	*	*	3
	Q4	413,966	98,154	6
		===============	===============	
		845,265	203,453	
	1995 Q1	*	*	3
	Q2	*	*	3

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

Table 5.5 Continued

City of Roma Los Saenz--Total Sales				
1993	Q1	11,265,744	6,322,969	180
	Q2	10,859,812	6,262,941	176
	Q3	11,373,801	6,154,269	176
	Q4	13,025,507	6,693,473	229
		===============	===============	
		46,524,864	25,433,652	
1994	Q1	11,204,685	5,853,730	177
	Q2	13,120,760	6,174,517	179
	Q3	11,426,587	6,433,549	179
	Q4	23,138,754	7,538,470	224
		===============	===============	
		58,890,786	26,000,266	
1995	Q1	10,071,984	5,755,396	180
	Q2	10,390,357	6,031,967	189
City of Roma Los Saenz--Retail Sales				
1993	Q1	10,197,378	5,884,640	139
	Q2	9,877,152	5,857,556	139
	Q3	10,496,247	5,776,526	137
	Q4	11,434,405	6,172,436	175
		===============	===============	
		42,005,182	23,691,158	
1994	Q1	9,486,375	5,146,656	139
	Q2	11,447,184	5,481,816	139
	Q3	9,822,963	5,788,462	138
	Q4	21,056,706	6,729,416	162
		===============	===============	
		51,813,228	23,146,350	
1995	Q1	8,701,914	5,010,906	136
	Q2	9,288,821	5,279,959	139

Table columns are: Year - quarter - gross sales - amount subject to state sales tax - number of reporting outlets.

CHAPTER 6. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

BACKGROUND AND OBJECTIVES

Given the dynamics of the Texas-Mexico border region, any analysis and forecast of its economic trends can prove a formidable task. Yet it is increasingly clear that economic growth — in particular that spurred by NAFTA — is being offset by border infrastructure damage. Efforts to provide the necessary rehabilitation cost effectively could be optimized through up-to-date trade and transportation data.

To streamline border data collection and storage, CTR developed in 1993 a TRANSBORDER data base for TxDOT. The main objective of the present study is to update and expand the scope of that data base. The data obtained under this study can be used immediately to assess infrastructure needs, to quantify the use of Texas' infrastructure by other states' commerce with Mexico (see Report 2932-2), to assess the impacts of the peso devaluation on transborder traffic (see Report 2932-2), to evaluate modal splits along the border, and to gain an understanding of energy and air quality issues related to transportation in Texas and in Mexico. The study deliverables can also assist TxDOT in fulfilling Texas Legislative Article 6673j-1 of the Texas Civil Statutes, which requires TxDOT to report on the ability of the Texas transportation system to handle traffic demand resulting from international trade. In addition, the data provided in this report can be used as evidence in support of the claim that Texas is the major gateway for the nation's NAFTA commerce, and as such sustains a disproportionate share of such consequences as pollution, excessive energy consumption in the transportation sector, and significant needs in terms of transportation infrastructure.

In addition to updating and expanding the existing TRANSBORDER data base, this study had two other objectives: (1) to analyze the early NAFTA and peso devaluation impacts on the border transportation demand, and (2) to estimate what portion of U.S.-Mexico trade originating in other states uses Texas' infrastructure. This first report has documented most of the project's primary objective, namely, to update and expand the TRANSBORDER data base. It discusses all relevant data collected and organized in this project, with the exception of international bridge demand and U.S.-Mexico overland commerce, which warranted a separate report (Report 2932-2). It also partly fulfills the other two objectives, presenting analyses of the peso devaluation effects and discussing the role of Texas' infrastructure in serving international commerce.

PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS

The data documented in this report provide an overview of the major issues affecting transportation planning in the 1990s, chief of which are compliance with ISTEA guidelines for transportation efficiency, NAFTA provisions for harmonizing truck weight limits, and the need for multimodal transportation. Relevant specifically to Texas are infrastructure needs resulting from the state's predominant role as the nation's gateway for NAFTA commerce.

Energy Consumption in the Transportation Sector

Texas is the highest consumer of energy in the U.S. If viewed as a separate political entity, Texas would rank fifth highest among all energy consumers in the world, behind the rest of the United States, China, Japan, Germany, and the former Soviet Union. By energy source, Texas is the largest consumer of natural gas, petroleum, and electricity, and the fourth largest consumer of coal (Ref 2.5). The principal energy source for transportation is petroleum, which has supplied over 90 percent of the state's energy needs since 1960. Natural gas is the next major source of energy for transportation, though its share of total consumption declined from 6.8 percent in 1960 to 3.9 percent in 1992. Similarly, liquid petroleum gas (LPG) represented less than 0.1 percent in 1992, down from 1.0 percent in 1960.

The Mexican and Texas data show marked differences in transportation energy use, basically reflecting Texas' higher reliance on low-occupancy automobiles and air transport. The Texas transportation sector consumed 2156 PJ in 1994, while Mexico's transportation system (nationwide) used 1432 PJ during 1991. In Mexico, autos, buses, and trucks consume around 90 percent of the fuel; airplanes, 6 percent; and rail and water, around 2 percent each. In Texas, autos, buses, and trucks also rank as the predominant consumers of energy, with 68 percent of the total. But unlike Mexico, air and waterborne transportation have a significant share of energy consumption (15 percent and 11.5 percent, respectively). The Mexican data indicate a trend toward a less efficient transportation system, with increased reliance on individual transportation by automobiles, and a significant decrease on such energy-efficient modes as rail and water.

The most important fuels in Texas and Mexico are gasoline and diesel. In Mexico, gasoline represents 67 percent of fuel usage, and diesel, 25 percent. In Texas, the percentages are 46 and 24 for gasoline and diesel, respectively. Other types of fuel contribute little to the total usage of energy both in Texas and in Mexico.

Energy consumption is becoming an increasingly important concern of transportation planners. The data collected in this study can assist those planners in developing a more efficient and environmentally friendly transportation system. In addition, given our rapidly changing transportation policies relating to air quality and multimodalism, we recommend that these data be periodically updated, since the policies under which current projections were obtained may be modified over time.

Mexican Truck Weights

Among the important provisions of the North American Free Trade Agreement (NAFTA) is the liberalization of truck traffic throughout the NAFTA territory (Ref 3.4). Before NAFTA, foreign trucks were required to remain within the commercial zone of both countries (a rather narrow strip along the border). This created a need for switching trucks at the border, a need that is often served by drayage companies specializing in hauling cargo from one side of the border to another. This procedure is the primary reason for the high percentages of empty trucks observed throughout the border (35 to 40 percent on average); it has also led to excessive energy consumption, worsening air quality, and congestion along the border.

The NAFTA liberalization of truck traffic has the potential to decrease the number of trucks crossing the border. However, Texas regulations regarding truck weight limits are more restrictive than those of either Mexico or Canada. Consequently, harmonization of truck weight limits has emerged as one of the more controversial issues relating to NAFTA: On the one hand, heavier trucks cause more pavement damage; on the other hand, if the heavier vehicles were allowed, fewer trucks would be needed to carry the same load, thus decreasing congestion, energy consumption, and pollution.

The truck weight data discussed in this report were collected for a truck size and weight study developed by the Instituto Mexicano del Transporte (IMT), the broad objectives of which relate to infrastructure management in Mexico. IMT's data indicate a tendency for Mexican freight companies to overload trucks as much as 40 percent above the limit for some truck classes. The most significant violations of weight limits occur for the smallest trucks. On the average, the largest trucks individually specified exceeded weight limits by 26 to 36 percent.

The IMT also estimated the number of additional truck trips necessary to carry the same freight tonnage without overloading any truck. Their analysis indicated that the new regulation is far better than that issued in 1980, since it has the advantage of reducing pavement and bridge consumption, while minimizing the increase in total number of trucks on Mexican highways (Ref 3.5). The IMT findings can be used to assess the potential for accepting Mexican and/or Canadian truck weights on Texas highways. Would this acceptance also result in a negligible decrease in the overall number of truck trips, analogous to that found by IMT? If so, there would be a strong argument against heavier trucks, since more infrastructure damage would not be offset by fewer trucks on Texas highways. It is worth noting that the percentage of empty trucks found in the Mexican survey is similar to that observed along the Texas-Mexico border.

We recommend a comprehensive two-phase study that would first investigate whether the potential decrease in the number of (empty) trucks on the border would compensate possible demand modal shifts from rail to heavier trucks. The second phase of the study should then investigate if the improvement in highway levels of service resulting from a decrease in number of trucks is sufficient to offset the costs of bridge and pavement upgrades for pre-selected "heavy-load" or NAFTA corridors. Since IMT intends to continue the truck weight data collection on a yearly basis, we also recommend that TxDOT follow up on the subsequent data updates and use them to supplement its other studies regarding the potential impacts of heavy trucks on its transportation infrastructure.

Multimodal Transportation

Motorists in Texas' urban areas confront congestion on a regular and growing basis. It is estimated that congestion costs consumers between $30 billion and $100 billion annually (Refs 4.1, 4.2). Accordingly, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires that states take steps to reduce not only congestion, but also energy consumption and air pollution, and that they promote economic development related to international commerce (Ref 4.3).

According to a recent report, TxDOT's efforts to enhance the viability of multimodal border transportation are important for relieving the stress on the highway network (Ref 4.14). The Texas-Mexico multimodal data discussed in this report can assist TxDOT's multimodal transportation efforts, while at the same time confirming the predominant role of Texas ports, rail infrastructure, and airports in serving NAFTA-related commerce. For example, the data show that:

(1) In 1992, NAFTA commerce by air totaled $2.86 billion, or 45 percent of worldwide total value of Mexican foreign commerce by air.

(2) In 1994, over 15 million tons of rail freight crossed the Texas-Mexico border; this is equivalent to over 71 percent of the rail freight crossing the U.S.-Mexico border.

(3) In 1994, over 243,000 freight rail cars crossed the Texas-Mexico border; this is equivalent to over 68 percent of all rail cars that crossed the U.S.-Mexico border.

(4) In 1991, over 523 billion tons, or less than 22 percent of Mexico's waterborne trade with the U.S. and Canada, had origins and destinations in Texas.

(5) In 1991, Texas ports handled over 816 billion tons, or nearly 38 percent of Mexico's waterborne trade with the U.S. and Canada; of these, over 293 billion tons, or over 12 percent, had neither origins nor destinations in Texas.

The data clearly indicate that Texas bears a disproportionate share of NAFTA commerce, and that it consequently sustains an equally disproportionate share of such problems as congestion, declining air quality, and the environmental problems associated with infrastructure construction. Periodic updates of the data discussed in this chapter are essential to TxDOT's efforts in planning for this infrastructure. Data summaries that highlight Texas' share in serving other states' commerce with Mexico can militate in favor of TxDOT's obtaining its share of federal funding for NAFTA-related commerce.

Socioeconomic Indicators

Texas sales data are an important indicator of transborder economic activity. Interviews with Customs inspectors, city officials, chamber of commerce personnel on both sides of the border, and maquiladora managers in Ciudad Acuña and Piedras Negras, indicated that retail sales in Texas were significantly affected by the peso devaluation. However, most persons interviewed were optimistic about a quick recovery of the Mexican economy. They also reported that most retailers were still active, though downsizing, and were expecting retail sales to soon return to normal levels.

Texas sales data tend to confirm the views expressed in the interviews: Sales revenues decreased considerably, but had not resulted in a significant number of business failures. The most significant impact of the peso devaluation occurred in Laredo, where there was a 36.5 percent drop in retail sales and a 35.5 percent decrease in total sales. Eagle Pass, whose retail sales dropped by 20 percent (from $139 million in 1994 to $111 million in 1995), sustained the second worst economic impact following the devaluation. Roma ranked second in total sales losses, with a 17 percent decrease. El Paso, which enjoys the largest share of sales revenues on the Texas-Mexico border, saw its 1995 sales remain at 1994 levels, while retail sales decreased more than 4 percent.

Harlingen was the only city whose total sales grew after the devaluation; in addition, Harlingen's total sales increased more over the 1994-1995 period (8.8 percent) than over the previous period (5.3 percent).

TRANSBORDER TRANSPORTATION DATA NEEDS AND INTERAGENCY COOPERATION

The data routinely collected by international inspection agencies are valuable for transportation planning. But because inspection agencies are unaware of transportation data needs, valuable information is often overlooked. This section discusses interagency cooperation, concluding with some suggestions for multi-purpose data collection.

A comprehensive binational study is currently underway, one financed by the U.S. and Mexican Governments and the World Bank and administered by the Arizona Department of Transportation. That study's main objectives are to develop guidelines for coordinated binational planning and to develop a comprehensive data base. The material in this section can be used by TxDOT as feedback for the binational study, whose other objective includes developing effective interagency cooperation, both in the U.S. and Mexico.

Background and Objectives

Many Texas-Mexico international bridges exhibit slow traffic flows and long queues, which in many cases are due to delays at inspection booths on both sides of the border. Therefore, provision of additional transportation infrastructure along the Texas-Mexico border may have the potential to disrupt traffic circulation even more if adequate inspection staffing is not provided for the new facility. This fact is somewhat counter-intuitive, since, in most other situations, additional infrastructure yields at least a marginal improvement in traffic circulation.

At the border, transportation planning should be a concerted effort among all agencies involved. However, interagency cooperation has not been the norm; rather, the traditional way of providing new crossings implicitly considers the perspectives of the many agencies mainly as sequential rather than integrated. These perspectives are summarized in Table 6.1.

Table 6.1 Perspectives in providing new international bridges and border crossings

Perspective	Objectives	Preferred Action
Local	- Maximize city revenues - Attract visitors to city - Improve traffic circulation	Build new bridges whenever they are profitable or may improve traffic circulation in the city.
Environmental	- Minimize Pollution - Maximize biota preservation - Minimize changes in river channel	Avoid new bridges that adversely affect the environment, and encourage them if they relieve "hot spots."
Inspection Agencies	- Minimize staff - Optimize equipment	Consolidate traffic into fewer bridges, preferably multi-modal.
Statewide Transportation Planning	- Maximize level of service of traffic circulation along the entire border - Minimize infrastructure costs	Undertake permanent, ongoing binational planning efforts.

Coordinated transportation planning requires a multi-dimensional perspective, one that considers the problem to its fullest extent, striving to optimize all the different viewpoints and objectives into one solution. Attempts to develop coordinated binational transportation planning for the Texas-Mexico border got underway in earnest in 1993, starting with TxDOT's Project 1976, a border-wide transportation planning study. More recently, these efforts have culminated in the approval of the first binational study to develop a coordinated transportation planning process, which is expected to be an important step towards better interagency cooperation.

Data Needs and Sources

A discussion of transportation data needs will illuminate some the recommendations presented later in this section. Ideally, every transportation study should be based on data that are as detailed as possible and which cover a geographical area as comprehensive as possible. However, this is not always practical; even if this type of data could be obtained in a cost-effective way, its subsequent analysis on a regional level would be too time consuming to yield timely results.

The level of data detail must vary with the scope of the study. In general, the larger the study area, the less detail is required, and vice-versa. Figure 6.1 and Table 6.2 compare data scopes for local and regional transportation planning studies. The first column of Table 6.2 corresponds to the numbers in Figure 6.1.

Point 1 in Figure 6.1 and Table 6.2 represents the data scope for local transportation studies (examples: feasibility of a new toll bridge; priorities for grade-separated intersections in a given city; local traffic circulation plans). While the geographical scope of the data is restricted to the area in question, the level of detail is high. Point 2 indicates the "ideal" situation of the detailed data for a wide geographical scope. This is not cost-effective or practical in any situation. Point 3 indicates the type of data required for regional transportation planning: The geographical scope is wide, but the level of detail is not comprehensive. Finally, point 4 shows the undesirable situation of data that are geographically restricted and not sufficiently detailed for local studies. However undesirable, point 4 reflects a situation that is often used, given the high costs of data collection and reduction.

During this and other border-related studies, CTR has observed that substantial amounts of valuable transportation planning information are collected daily by inspection agencies on both sides of the border; yet in many cases, this information is either not stored, or is stored in a way that is inadequate for transportation planning uses. This lack of coordination limits the available data and requires costly procedures to collect data that could be obtained by a fraction of that cost through interagency cooperation. Below are some suggestions for data collection through interagency cooperation.

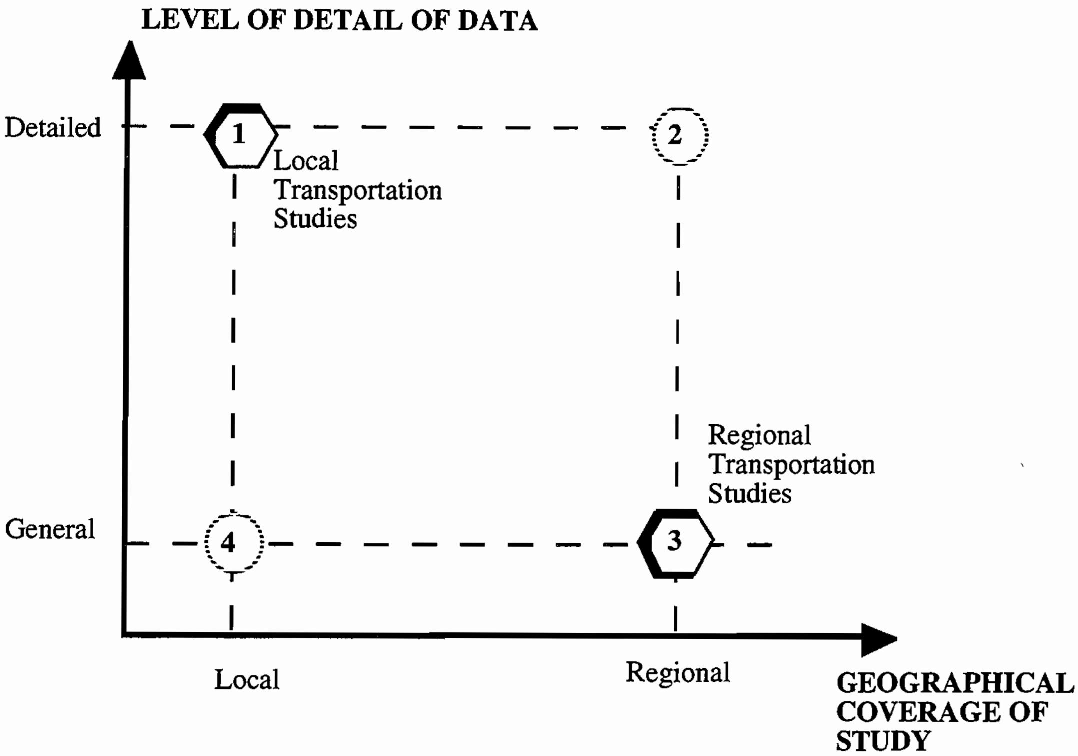

Figure 6.1 Data scope for transportation studies

Table 6.2 Data scope for transportation studies

Data Scope	Data Use	Data Limitations
1	Local transportation studies	Cost effective only on micro-analysis
2	All (ideal data base)	Too costly to be feasible in practice
3	Regional transportation studies	Suited only for macro-analysis
4	None	Not enough detail of micro-analysis, not enough coverage for macro-analysis

Truck and Rail Data

A considerable portion of U.S.-Mexico trade is handled by rail and truck. The following basic types of data are needed for planning and managing truck traffic:

(1) Truck size and weight, for design and management of pavements and bridges, highway and bridge design, and analysis of potential for multimodal diversion

(2) Number and weight of rails cars

(3) Truck counts, for design and management of pavements and bridges, highway and bridge design, capacity utilization analysis, analysis of potential for multimodal diversion, and traffic assignment modeling

(4) Origin and destination (O&D) by commodity type, for scheduling of maintenance priorities for pavements, bridges, railroads, and intermodal yards, highway planning, analysis of potential for multimodal diversion, multimodal traffic assignment modeling, and analysis of trade corridors. O&D information used to be protected by confidentiality agreements, and only recently has become available for general use (see Report 2932-2).

While these three types of data are partially available, they are limited insofar as they are usually collected for objectives other than transportation planning. For example, information is available on truck weight, number of trucks, and truck O&D by commodity type; but these data are collected by different agencies, for different purposes. This is true for rail data as well. The information needed for transportation planning is in the format of *trucks (or rail cars) by weight, commodity type, and O&D.* In order to arrive at this format, it is necessary to combine different data sources using assumptions that decrease the reliability of the data.

The commodity flow data obtained by Project 2932 are as detailed as possible and contain a wealth of useful information, including the usually undisclosed commodity origin and destination. The amount of information was so significant that it warranted a separate report (Report 2932-2); nevertheless, a brief discussion of improvements in the data collection process is relevant and was included here.

Commodity O&D data sources are basically the Customs documents required by law. The law requires a shipment document (manifest) for each type of commodity, and data are stored by document, not by vehicle. One shipment would be equal to one truck (or rail car) only if each had only one type of commodity. According to U.S. Customs Port Directors along the border, this is not always the case. Given the present method of storing information, it is impossible to match trucks and rail cars to shipments. Number of trucks and rail cars by O&D pair could be estimated if the ratio between total number of trucks (available) and total number of shipments (available) were known. Underlying this method is the assumption that every type of commodity found in the O&D data base is present in mixed loads with the exact same frequency. Actually, these frequencies are unknown, and would be greater for commodities frequently present in multiple loads, and lower for commodities hardly (or never) present in multiple loads.

Commodity origins are stored either as "state of origin" or "state of exporter." However, neither measure provides a true representation of the *production* origin of exports. *State of origin* may be the state that contains a consolidation point, such as Louisiana for agricultural shipments. This yields accurate, though incomplete, origin information: only the consolidation/destination leg on the trip is known, while the production/consolidation part remains unknown. *State of exporter* may be the state where the exporter's corporate headquarters are located, and may have nothing to do with the actual commodity route.

Shipments in-transit through the U.S. (i.e., shipments that neither originate nor terminate in the U.S.) are not included in the available data, which are restricted to U.S. imports and exports. An analogous situation holds for Mexican commodity data. Thus, U.S. data *underestimate* NAFTA shipments in-transit through Texas, since they do not include Canada-Mexico commerce by land. U.S. data must be corrected using Mexican data, which do include Canada-Mexico commerce; these adjustments always result in loss of overall reliability, owing to differences in data formats.

Overcoming these limitations will require active interagency cooperation. This cooperation could involve collecting and storing commodity information in the following manner:

(1) Store each record by manifest number.

(2) If the shipment is part of a multiple load, indicate the numbers of the other shipments' manifests that are loaded on the same truck.

(3) Each consolidation point provides the actual origin and transport mode of each load being taken to the consolidator.

(4) Manifests indicating the location of the exporter's corporate headquarters must also include the location of any consolidation points to be used during the export process.

The practical feasibility of collecting this type of information has to be discussed with Customs, Customs brokers, exporters/importers, and the agency responsible for organizing and disseminating the information (perhaps the USDOT). One way to fund the implementation of this new system would be to provide a small tax-break to those willing to provide the additional information. This tax break could be levied based on an estimate of the benefit of obtaining such information for transportation planning purposes.

Table 6.3 summarizes truck and rail data that could be obtained through interagency cooperation. These recommendations are tentative; obviously, they need to be refined through discussions with Customs representatives on both sides of the border, preferably through the binational study.

Table 6.3 Suggested interagency cooperation for truck data

Data Type	Recommended Procedures
Truck size & weight Rail cars	1. Require that estimates of truck/rail cars weight be part of the customs manifest; or 2. Install permanent weigh stations at Customs or at bridge exits and entrances.
O&D by commodity type	Require additional information in shipping documentation.
Truck/rail cars counts	Require that manifests include information on multiple commodities in one truck/rail car.

Waterborne and Airborne Transport

Although considerations similar to those discussed above for trains and trucks can be applicable with some adaptations to airborne freight, an air cargo data base of import/export shipment declarations is not as easy to organize. Air transport is typically used to ship small, light, and more valuable loads; both cargo and passenger airplanes may contain several shipments, and the establishment of a system conducive to matching number and frequency of airplanes with commodity O&D is not as straightforward as it is for surface transport modes, where there are considerably fewer multiple loads. We recommend that TxDOT and the USDOT schedule a meeting with representatives of air transport and express-mail companies to discuss the best way to obtain transportation planning information.

Mexican waterborne transportation data (see Chapter 4) are rather comprehensive. Some data bases available through MARAD are also helpful in this regard, though matching information from both countries usually requires additional assumptions. A specific study is recommended to develop guidelines for binational interagency cooperation in collecting waterborne data, ideally as a follow-up to the preliminary discussions of the binational study.

International Bridge Data

Data on origin and destination of transborder passenger traffic collected by CTR prior to NAFTA indicate that 80 to 95 percent of all auto traffic at international bridges represents traffic traveling between sister cities. As such, international auto traffic pertains primarily to a local, urban transportation planning perspective.

Passenger traffic counts are usually recorded by bridge managers on both sides of the border, as well as by U.S. Customs. Although some data manipulation is necessary to obtain a uniform and coherent data series for all international bridges, basic data needs for regional transportation planning are essentially met, since monthly counts are available borderwide for both northbound and southbound directions. Other data needs, however, are not addressed with this data storage system, though they could be with better interagency cooperation.

Local transportation studies, such as traffic circulation plans for a border city or a revenue analysis for a proposed new toll bridge, ideally require hourly traffic counts at the bridges and at the network considered for expansion. And while TxDOT already has permanent traffic counters installed at most highways inside border cities and/or near international bridges, we are *not* advocating periodic collection of hourly counts over the entire network of border cities. This is the kind of effort that can be cost effective only if handled on an as-needed basis. However, hourly traffic counts are routinely collected by bridge managers and inspectors on both sides of the border. Yet few of them routinely store the data by the hour. Hourly data are of little use to managers or accountants; moreover, they require a storage space at least 720 times larger than that required for monthly data. On the other hand, data storage is increasingly cost effective and practical; a moderately priced computer can store information for less than $3 per megabyte. We recommend that bridge managers, border inspectors, and transportation planning agencies make an effort to store the hourly counts on a regular basis; such an effort can yield a baseline data bank that can be used for any detailed traffic circulation study.

Another type of data that is necessary for both regional and local transportation planning is origin and destination. The level of detail varies with the scope of the study, as discussed before and illustrated in Figure 6.1. A regional transportation planning study needs to detail O&D only by city. Studies that are local in scope, such as traffic circulation plans for border cities or a revenue analysis for a proposed toll bridge, must disaggregate the sister cities into smaller areas of traffic production and attraction. The latter type of data is not regularly collected by any agency, and would certainly be best addressed on a case-by-case basis. However, we have consistently observed that the border inspectors who check passports at the U.S. entry points regularly ask origin and destination information on a macro-level suitable for regional transportation planning. Interviews with these inspectors revealed that they record these data. Interagency cooperation between the Immigration and Naturalization Service (INS) and transportation planners would ensure a steady flow of northbound O&D data for a fraction of the cost of in-situ O&D surveys.

Conclusions

The discussion above is based on our experience with border data obtained in Projects 1976, 2932, and others. Such experience indicates that some routine procedures followed by inspection agencies have a significant potential to provide several categories of the data needed for transportation planning, and at a fraction of the cost of data collection on a case-by-case basis. The discussion above is intended to assist TxDOT in developing recommendations for streamlining the international traffic data collection, which could be discussed with the staff of the binational study.

RECOMMENDATIONS FOR FUTURE STUDIES

A binational study is underway, financed by the U.S. and Mexican Governments and the World Bank, and administered by the Arizona Department of Transportation. That study's main objective is to develop guidelines for coordinated binational planning. Nevertheless, it does not pursue objectives that are Texas-specific; therefore, we propose that TxDOT begin the process of quantifying the infrastructure needs resulting from Texas' important role as a major national trade corridor. Accordingly, we recommend research to investigate such relevant issues as:

(1) additional highway capacity needed in Texas as a result of other states' international commerce passing through the state;

(2) pavement rehabilitation needs caused by other states' international commerce;

(3) impacts of heavier (Mexican and Canadian) trucks on Texas highways, in terms of both increased pavement consumption and decreased congestion and pollution;

(4) traffic safety hazards related to other states' international commerce passing through the state; and

(5) mobile source emissions in Texas' non-attainment areas (such as El Paso) generated by vehicles serving other states' international commerce.

Studies such as those listed above can help Texas obtain its share of funds for transportation infrastructure and attainment of Clean Air Act requirements. Results of these studies can also help relieve Texas border communities — El Paso, Laredo, and many others — of the congestion, pollution, and environmental degradation resulting from NAFTA-driven trade traffic.